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SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

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A Journal for all SCIENCE AND MATHEMATICS TEACHERS

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Earth Knowledge
The Chemistry Library
Subtraction of Signed Numbers
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SCHOOL SCIENCE AND MATHEMATICS

VOL. XXIX No. 8 NOVEMBER, 1929 WHOLE NO. 253

EDUCATION OR ENTERTAINMENT?

The past quarter century has witnessed marvelous progress in popular education, especially in scientific education. Popular science books have appeared by the hundreds; there are many good science magazines for the layman; every daily newspaper has its science section. It is a wonderful step in advance of the superstition and mystery of a few years ago. This splendid progress is sufficient reason for pride in our educational agencies —schools, churches, publications, films, museums, lectures, etc. It is a good return on the money invested and encourages us to increase our holdings in these institutions. Every day brings new discoveries and creates a demand for more books and magazines.

But in this noble attempt to make this wonderful knowledge a common possession we must not forget the method of its discovery. Is there not much danger at present that the methods used to satisfy the layman (and in many cases he must be satisfied with vague ideas) will hinder a very important function of the school? Vague ideas are only the first step in science education. Science demands correct ideas and definite, accurate expression. The school is the place to learn the facts of science and the method by which they were discovered, also to give practice in the interpretation and application of scientific principles. The time to begin this type of learning is contemporary with the beginning of the study of science. It is just as easy to acquire correct and definite knowledge as to acquire vague and inaccurate notions, if conditions are right.

The school should provide the child with popular science literature, show him educational films and demonstrations, take him to museums, include lectures and travel if possible, but

before the school has passed him it should see that he has a definite understanding of some scientific laws, that he can express them accurately and apply them understandingly. Otherwise he will not have acquired a scientific attitude of mind nor will he ever be able to enjoy any other than sugar-coated science. The school program should be more than a series of interesting entertainments. Scientists are not produced by parlor games any more than are gridiron warriors. They must acquire the necessary patience and skill by actual laboratory experience; they must learn to think scientifically. Mastery of mathematical operations and training in applying them are fundamental and necessary parts of real science education because mathematics is the language of science.

EDWIN E. SLOSSON.

In the death of Dr. Edwin Emery Slosson on Oct. 15 the country lost one of the greatest of science educators. Laymen, high school students and college professors alike enjoy his "Creative Chemistry," "Chats on Science" and "Easy Lessons in Einstein." As a popular lecturer on science topics he had no superiors and few, if any equals. As Director of Science Service he carried the news of discovery in science to the four corners of the earth. As scientist, teacher, lecturer, educator and journalist he built a monument that time will not soon destroy.

Dr. Slosson was born in Albany, Kansas, June 7, 1865. He received his early education in the public schools and graduated from the University of Kansas, receiving his B. S. degree in 1890 and M. S. in 1892. Later he studied under Dr. Stieglitz at the University of Chicago and was granted the Ph. D. degree in 1902. From 1891-1903 he was professor of chemistry at the University of Wyoming and chemist of the Wyoming Agricultural Experiment Station. In these positions he continued his studies of petroleum and its derivatives. His next position, literary editor of The Independent, shows his great versatility. This work and an associate professorship at the Columbia School of Journalism gave him the experience needed to fit him preeminently for his final work as Director of Science Service which he held from the organization of that institution in 1920 until his death. He was a fellow of the American Association for the Advancement of Science, a member of Phi Beta Kappa, Sigma Xi and the Washington Academy of Science.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

Plans are now completed for the twenty-ninth annual meeting of the Central Association of Science and Mathematics Teachers to be held at the University of Chicago, Nov. 29 and 30. The programs, general and sectional, given on pages 904-908 of this issue of the Journal, merit the careful consideration of every science and mathematics teacher. One cannot afford to miss the opportunity which these programs offer to hear speakers of outstanding ability. Neither can one afford to miss the helpful and stimulating discussions which follow papers in the sectional meetings.

The annual dinner will be a happy occasion. We are especially fortunate in having for our after dinner speaker Dr. William M. McGovern, a noted explorer and anthropologist connected with Field Museum and Northwestern University. He will address us on "Asia in World History." It is a privilege to hear Dr. McGovern. Everyone should plan to attend the dinner and the lecture following it.

If you have not already decided to attend the meeting, the program, I believe, will help you to reach that decision. Our goal this year is a record attendance and a paid up membership of one thousand. Do your share.

ADA L. WECKEL.

AMERICA KNOWN TO WORLD THROUGH THE RED CROSS.

While the American Flag is a familiar emblem in every part of the world, there is another which is almost equally familiar, and to many foreign races and places, is identical. The second emblem is that of the American Red Cross.

Since the end of the World War, so many foreign nations have experienced the generosity of the American People in periods of foreign distress and have come to understand that this is extended through the Red Cross, that to them, the Red Cross is *America*.

In all Red Cross activities, the Junior Red Cross in America's schools can claim a major share. Through the international correspondence between American School students and those of more than a score of foreign nationalities; through the numerous helpful projects encouraged, or maintained outright by the American Juniors through their Children's Fund, the far-reaching helping hand of the Red Cross has extended to virtually all parts of the world in recent years.

Foreign peoples are right in their view of the American Red Cross in this way; it represents the people of the whole United States, without regard to creed, race, or color, and its services at home or abroad, are rendered in behalf of the whole nation.

Once each year, from November 11 to 28, it asks the enrollment of every one in America, to maintain its nation-wide membership, and to keep its varied services always efficient and ready.

Join!

ELECTRICAL CONVECTION CURRENTS.

By T. Sidney Elston,
Pasadena Junior College, Pasadena, Calif.

I. *Rowland's Experiment*

Faraday believed that a stream of charged particles in motion through space should produce a magnetic field similar to that produced by an ordinary conduction current flowing along a wire stretched along the path of the moving particles. In support of this belief Professor Rowland in 1876, and later, proved by experiment that a body charged with electricity and rotated in a circle produces magnetic effects at the center of the circle equal to those which would be produced by a conduction current having the same path. He called the moving charge a convection current, and his experiment proved that its equivalent conduction current would have to have the value

$$I = Q\,v/L \text{ amperes} \quad \ldots\ldots (A)$$

where Q is the charge in coulombs, L is the path-length in cm., and v is the velocity in cm. per sec. of the moving charge. For example, if Q/L is 1/3000th coulomb-per-cm. along the convection-path and v is 3000 cm./sec. (approximately the speed used in Professor Rowland's experiment), then I = 1 ampere.

The foregoing relation between convection currents and conduction currents has wide application in modern electronic theory.

II. *Single Electron in a Circular Path*

Consider the case of a single electron of charge e (Fig. 1a)

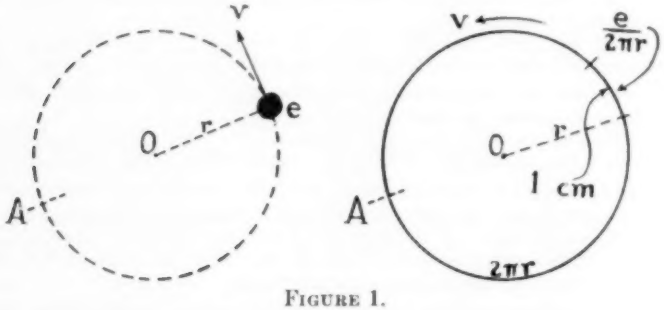


Figure 1.

moving at a constant speed v in a circular path of radius r about a central nucleus o. Let it be required to calculate H the magnetic field strength at o due to the motion of e. There are two methods which suggest themselves:

(1) The value H of the magnetic field strength at o can be calculated directly from the formula, derived from the classical electrodynamics,

$$H = e\,v/c\,r^2 \text{ gauss} \quad (1),$$

wherein e is in electrostatic units, v is in cm. per sec., r is in cm., and c is the factor (3×10^{10}) to reduce the charge from electrostatic units to electromagnetic units.

(2) The value H of the magnetic field strength at o can also be calculated from the well-known formula, derived from Ampere's law,

$$H = 2\pi i/r \text{ gauss} \quad (2),$$

wherein i is the equivalent conduction current in the circumference of the circle and is measured in electromagnetic units. The current i must be expressed in terms of e and v, and this can be done in two ways:

(a) One way is through the definition of current as "the charge-per-second which passes a given point in the circuit."

Let n be the number of revolutions per second made by the electron represented in Fig. 1a. Then the current past any point A in the circuit is

$$i = ne/c \text{ abamperes} \quad (3),$$

where

$$n = v/2\pi r;$$

for it is quite evident that n must equal the total distance traveled per sec. divided by the distance traveled in one revolution. Substituting this value of i into Eq. (2), we get $H = ev/cr^2$ gauss, the same result as obtained by the first method.

(b) Another way of getting i is through the application of Rowland's experimental formula

$$i = qv/cL \text{ abamperes} \quad (4),$$

wherein q is the total charge in electrostatic units in a circuit whose length is L cm., v is the velocity of the charge, and c is the factor (3×10^{10}) to reduce the charge from electrostatic to electromagnetic units.

In the present case $q = e$ and $L = 2\pi r$. By substituting these values in Eqs. (4) and (2) we get $H = ev/cr^2$ gauss, the same result as obtained by the first method.

An easy way of remembering the correct expression for the convection current is to picture the electron charge (Fig. 1b) as smeared in a uniform streak along the whole orbit (á la de Broglie). The product of the velocity v and the charge per cm. $(e/c\ 2\pi r)$ of this orbital streak gives $ev/c\ 2\pi r$ abamperes as the

correct formula for the convection current in this present case.

In an actual atom we may assume that $e = 4.774 \times 10^{-10}$ e. s. u., $v = 10^9$ cm. per sec., and $r = 10^{-8}$ cm. The above formula then gives $H = 1.591 \times 10^5$ gauss as the magnetic field strength at the center of the atom.

III. *Single Electron in a Straight Path*

Consider the case of a single electron of charge e moving at a constant velocity v in the straight line AB (Fig. 2). Let it be required to calculate the magnetic field strength at a point P a distance r from AB.

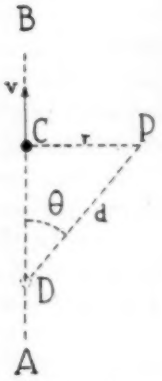


FIGURE 2.

Only the first of the methods used above will apply here. When the electron is at the point C in its path, this method (Eq. 1) gives $H = ev/cr^2$ gauss as the magnetic field strength at P.

When the electron is at any other point D in its path, this method gives $H = ev \sin \theta / cd^2$ gauss, the component $v \sin \theta$ being substituted for the velocity v because only the component of the velocity which is normal to d is effective in producing a magnetic field atP.

The other method used above, the one (Eq. 2) in which the magnetic field strength is expressed in terms of the equivalent conduction current, is not applicable here because the single electron moving in a straight line cannot be made to conform to our definition of current. Although the charge e passes each point in the path, the time-rate (or current) at which it passes any chosen point is infinitely large at the instant of passage and is zero at all other times before and afterward; and it is not possible to average the charge over the whole path and time as was done in the case of the electron moving in a closed path.

IV. *Procession of Electrons in a Straight Line*

Consider the case of a procession of N electrons equally spaced and moving with a uniform velocity v in a long straight line AB (Fig. 3) whose length is L. Let it be required to calculate the magnetic field strength at a point P a distance r from AB.

Methods almost identical with those used in the case of the electron in the two cases already considered will apply here.

(1) The magnetic field at P due to a single electron, such as the one at D, is $ev \sin \theta / cd^2$ gauss. By summing the effects at P due to all the electrons in AB (which is assumed to be indefinitely long), we get

$$H = 2\,nev/cr \text{ gauss} \quad \ldots\ldots (5),$$

where n is N/L, i.e. the number of electrons per cm.

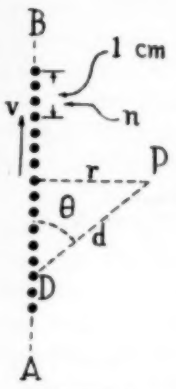


FIGURE 3.

(2) The magnetic field strength at P can also be calculated from Biot and Savart's law

$$H = 2\,i/r \text{ gauss} \quad \ldots\ldots (6),$$

wherein i is the equivalent conduction current in abamperes. The current i may be interpreted in terms of the electron charge e and its velocity v in two ways, as already shown above:

(a) One way is through the definition of current as the charge per second passing a given point. We get

$$i = (nv)\,e/c \text{ abamperes} \quad \ldots\ldots (7);$$

for (nv) is the number of electrons per second which pass a given point, e is the charge per electron in electrostatic units, and c is the factor (3×10^{10}) to reduce the charge from electrostatic to electromagnetic units. By substituting from Eq. (7) into Eq. (6) we get $H = 2\,nev/cr$ gauss, the same result as obtained by the first method.

(b) Another way is through the application of Rowland's experimental convection-current formula $i = qv/cL$. (See Eq. 4.) In the present case $q/L = ne$, for both give the charge per centimeter-length of path. By substituting in Eq. (6) we get $H = 2\,nev/cr$ gauss, the same result as obtained by the other methods.

V. *Space-Charge Moving Normally Across a Surface*

Consider the case of a region or space filled uniformly with a charge whose density is ρ electrostatic units per cc. and which is moving with a uniform velocity v at right angles to the surface ABCD (Fig. 4). Let it be required to calculate the value of the equivalent conducton current.

If we let i′ be the current density (i.e. the current per cm² across the surface ABCD), then i′ can be found in two ways:

(a) One way is through the definition of current density as the charge-per-sec. per cm² moving across the surface ABCD. We get

$$i' = \rho v/c \text{ abamperes per cm}^2 \quad \ldots\ldots (8);$$

for ρ is the charge in 1 cm. length of a tube 1 cm² in cross-section,

and in 1 sec. the total number of these cubes to pass along the tube across the surface ABCD is v, and c is the factor to reduce the charge from electrostatic to electromagnetic units.

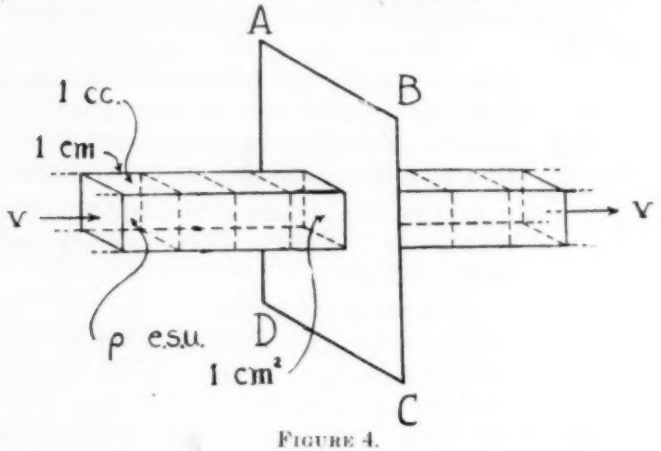


FIGURE 4.

(b) Another way is through the application of Rowland's experimental convection-current formula (Eq. 4).

If we let q′ be the charge in electrostatic units per cm. length of a tube of unit cross-section moving across the surface ABCD, then we get

$$i' = q'v/c \text{ abamperes per cm}^2 \quad \ldots\ldots (9).$$

In the present case it is evident that $q' = \rho$; hence $i' = \rho v/c$ abamperes per cm², the same result as obtained by the other method.

VI. *Convection-Current Formulae Confirmed by Dimensions*

Indirect evidence of the correctness of Rowland's formula for electric convection currents is found in the dimensions of the quantities involved.

(1) Take Equation (A) or (4), $i = qv/cL$ abamperes. The dimensions of v are [L/T], the dimension of L is (L), and the factor c has no dimensions, for it is a pure number. Hence the resulting dimensions of the righthand side of the equation are [q(L/T)/L], or [q/T], which is the dimensional formula for electric current.

(2) Take Equation (7), $i = nev/c$ abamperes. The dimensions of ne are [q/L], the dimensions of v are [L/T], and c has no dimensions. Hence the resulting dimensions of the righthand side of the equation are [q/T] which is the dimensional formula for electric current.

(3) Take equation (8), $i' = \rho v/c$ abamperes per cm^2. The dimensions of ρ are $[q/L^3]$, the dimensions of v are [L/T], and c has no dimensions. Hence the resulting dimensions of the righthand side of the equation are $[q/TL^2]$ which is the dimensional formula for electric current density.

(4) Take some of the formulae derived from the convection-current formula, such for instance as $H = ev/cr^2$ (Eq. 1) and $H = 2\,nev/cr$ (Eq. 5). The dimensions of the righthand members of these two equations are readily determined from the definitions of the quantities, provided account is also taken of the fact that μk, the product of the magnetic permeability μ and the dielectric constant k has the dimensions of $1/v^2$. The righthand members of both equations have the dimensions of magnetic field strength H.

All dimensional tests of this kind are in complete agreement with the convection-current formula as interpreted in this discussion. Quite often it is a moot question as to whether a given formula should contain the magnetic field strength H or the magnetic induction or flux density $B[= \mu H]$. The dimensional tests above show that in all the formulae discussed here it is H and not B that is involved.

(*Note:* When the reciprocal action exerted by a magnetic pole on a current-carrying wire is considered, the formula for the mechanical force exerted is quite often incorrectly written $F = H'i'L = H'\,ev/c$ dynes. The dimensional test when applied to this formula shows that the magnetic induction B′ should be substituted here in the place of the magnetic field strength H′.)

VII. *A Popular Misconception*

In many of our elementary College Textbooks of Physics erroneous interpretations of Rowland's convection-current experiments have occurred. The error usually made has consisted in substituting the total charge e (or q), instead of the charge per unit path-length e/L (or q/L), in the product of charge and velocity which represents the convection current. The numerical error of calculation to which such a mistake gives rise is sometimes very large; for example, the calculation shown above (Sect. II) of the magnetic field-strength at the center of an atom would then give 0.01 gauss instead of the true value 159,100 gauss.

This serves to emphasize the general rule that, *with due regard to units, the value of an electric convection-current is found by multiplying the average charge-per-unit-length-of-path by its linear velocity.*

TWO REPRESENTATIVE PROBLEMS AND THEIR HISTORIC SETTING.*

By Edwin W. Schreiber,

Ann Arbor, Mich.

"Thus the equation $X^2+10x=39$ runs like a thread of gold through the algebras for several centuries." So writes Professor Louis C. Karpinski in his scholarly work—Robert of Chester's Latin Translation of the Algebra of Al-Khowarizmi (Macmillan, 1915). Neither the date of the birth or death of Al-Khowarizmi has been definitely established but the height of his literary activity may reasonably be placed about 825 A. D.

Al-Khowarizmi gives the analytical solution of the above quadratic equation in Chapter IV, entitled: Concerning squares and roots equal to numbers. I quote from Karpinski's translation.

"The following is an example of squares and roots equal to numbers: A square and 10 roots are equal to 39 units. The question therefore in this type of equation is about as follows: What is the square which combined with ten of its roots will give a sum total of 39? The manner of solving this type of equation is to take one-half of the roots just mentioned. Now the roots in the problem before us are 10. Therefore take 5, which multiplied by itself gives 25, an amount which you add to 39, giving 64. Having taken then the square root of this which is 8, subtract from it the half of the roots, 5, leaving 3. The number three therefore represents one root of this square, which itself, of course, is 9. Nine therefore gives that square.

"Now, however, it is necessary that we should demonstrate geometrically the truth of the same problems which we have explained in numbers. Therefore our first proposition is this, that a square and 10 roots equal 39 units.

"The proof is that we construct a square of unknown sides,

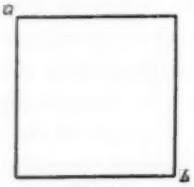


Fig. 1

and let this square figure represent the square (second power of

*This paper was presented at the Mathematics Conference of the Michigan Schoolmaster's Club, University of Michigan, April 26, 1929.

the unknown) which together with its root you wish to find. Let the square, then, be ab (Fig. 1), of which any side represents one root. When we multiply any side of this by a number (pure number) it is evident that that which results from the multiplication will be a number of roots equal to the root of the same number (of the square). Since then ten roots were proposed with the square, we take a fourth part of the number then and apply to each side of the square an area of equidistant sides, of which the length of the square first described and the breadth $2\frac{1}{2}$, which is a fourth part of 10. Therefore four areas of equidistant sides are applied to the first square, ab (Fig. 2). Of each of these the

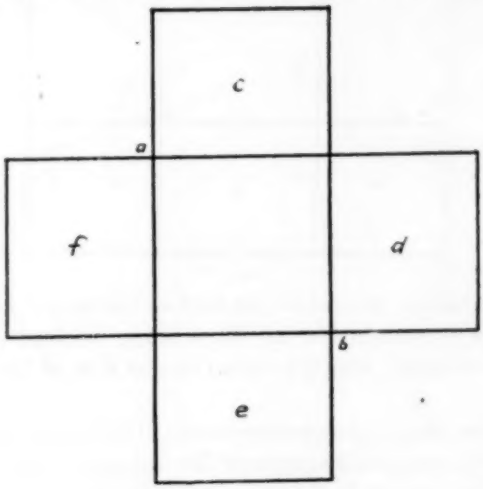


Fig. 2.

length is the length of one root of the square ab and also the breadth of each is $2\frac{1}{2}$, as we have just said. These now are the areas, c, d, e, f. Therefore it follows from what we have said that there will be four areas having sides of unequal length, which also are regarded as unknown.

"The size of the areas in each of the four corners, which is found by multiplying $2\frac{1}{2}$ by $2\frac{1}{2}$, completes that which is lacking in the larger or whole square (Fig. 3). Whence it is that we complete the drawing of the larger area by the addition of the four products, each $2\frac{1}{2}$ by $2\frac{1}{2}$; the whole of this multiplication gives 25.

"And now it is evident that the first square figures, which represents the square of the unknown (X^2), and the four surrounding areas (10x) make 39. When we add 25 to this, that is. the

four smaller squares which indeed are placed at the four angles of the square ab, the drawing of the larger square, called GH is completed. Whence also the sum total of this is 64, of which 8 is the root and by this is designated one side of the completed figure. Therefore when we subtract from eight twice the fourth

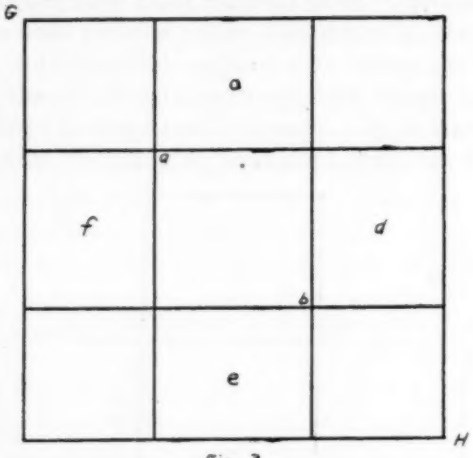


Fig. 3

part of 10, which is placed at the extremities of the larger square GH, there will remain but 3. Five being subtracted from 8, 3 necessarily remains, which is equal to one side of the first square ab.

"This three then expresses one root of the square figure, that is, one root of the proposed square of the unknown, and 9 the square itself. Hence we take half of ten and multiply this by itself. We then add the whole product of the multiplication to 39, that the drawing of the larger square GH may be completed; for the lack of the four corners rendered incomplete the drawing of the whole of this square. Now it is evident that the fourth part of any number multiplied by itself and then multiplied by four gives the same number as half of the number multiplied by itself, $4\left(\frac{a}{4}\right)^2 = \left(\frac{a}{2}\right)^2$. Therefore if half of the roots is multiplied by itself, the sum total of this multiplication will wipe out, equal or cancel the multiplication of the fourth part by itself and then by four."

And so we have Al-Khowarizmi's method of solving a quadratic equation, a method which has much to offer in the way of enlightenment on "completing the square." Our boys and girls

of the twentieth century will be interested in observing how the scholar of Bagdad solved his problems in the ninth century.

Now let us turn for a few minutes to a brief historical survey of the problem of inscribing a regular pentagon in a circle. This is an exceedingly interesting problem though I fear that in our present courses in plane geometry too little attention is given to it. In a good many of our modern textbooks the following method is given, Fig. 4:

Draw the radius OA of the given circle whose center is O and divide OA at M into extreme and mean ratio. OM applied as a cord 10 times gives a regular decagon and if alternate vertices of this decagon are joined we obtain the regular pentagon ACEGI.

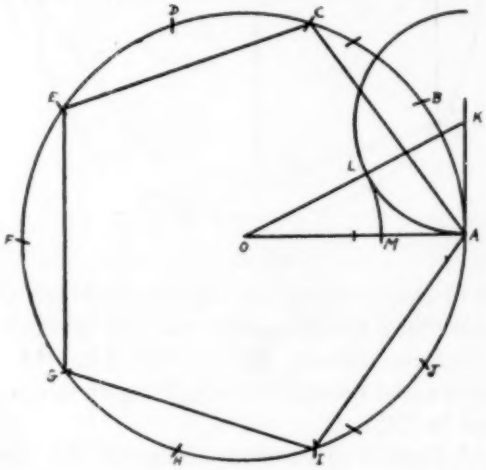


Fig. 4

This method of constructing the regular pentagon appears perhaps the most frequently in the literature and was first recorded (according to Tropfke) by Pappus of Alexandria about 300 A. D. The particular method illustrated in the figure for determining the point M which divides the line OA in extreme and mean ratio is attributed to Heron of Alexandria some time in the first century before Christ. It reappeared in the seventeenth century in "Clavis Mathematicae" (1631) by Wm. Oughtred, the inventor of the slide-rule, and about a hundred years later (1717) received wide publicity through the writings of Christian von Wolff.

A very simple method of constructing the regular pentagon is shown in Fig. 5. Let AK and FL be two perpendicular diameters.

G is the midpoint of KO. With G as center and GF as radius determine point H. FH is the side of the pentagon. It is of interest to note that in the right triangle FOH, OH is the side of the regular decagon and OF the side of the regular hexagon.

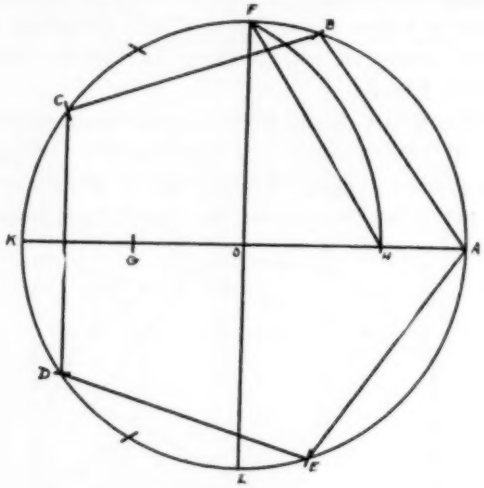


Fig. 5.

This method of constructing the regular pentagon is a century and a half older than the preceding one and is due to the great astronomer Ptolemy (about 150 A. D.) Albrecht Dürer, the famous German artist brought it to light again in one of his writings published in 1525.

But what of Euclid? How does he handle this problem? To quote from T. L. Heath—The Thirteen Books of Euclid's Elements (Cambridge University Press, Macmillan Co., 1926) "Euclid's work will live long after all the textbooks of the present day are superseded and forgotten. It is one of the noblest monuments of antiquity; no mathematician worthy of the name can afford not to know Euclid, the real Euclid as distinct from any revised or rewritten versions which will serve for school boys or engineers. And to know Euclid, it is necessary to know his language, and, so far as it can be traced, the history of the elements which he collected in his immortal work."

We find our problem in the fourth book of Euclid, Proposition 11, stated in the following words, (Heath) "In a given circle to inscribe an equilateral and equiangular pentagon." The method is as follows: (Fig. 6.) Inscribe in the given circle the isosceles triangle ACD in which the base angle at C is double the vertex

angle at A. D, C and A are three of the required vertices of the regular pentagon. The remaining two, B and E, are determined by bisecting the base angles C and D.

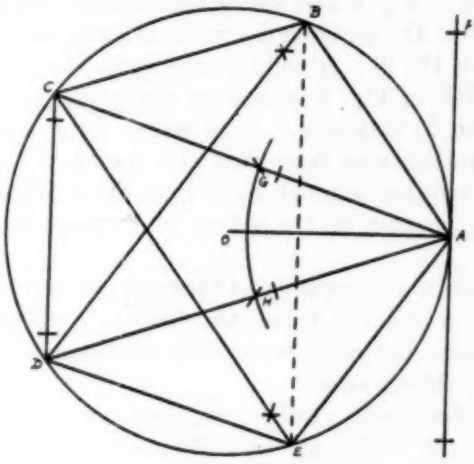


Fig. 6

Fig. 7 gives Euclid's method of dividing a line into extreme and mean ratio (Book II, 11) or as he states: "To cut a given straight line so that the rectangle contained by the whole and one of the segments is equal to the square on the remaining segment." Let

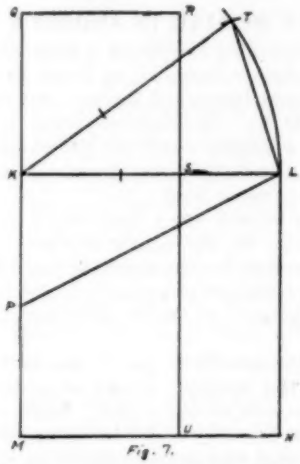


Fig. 7.

KL be the given line segment. Upon KL as a side erect the square KLNM. P is the midpoint of KM. Draw PL. Extend PK to Q making PQ equal to PL. Upon KQ as a side erect the square KQRS. S is the required point that divides KL in extreme

and mean ratio. In Fig. 7 the isosceles triangle KLT is drawn such that LT equals KS and thus is an isosceles triangle whose base angle T is double the vertex angle K. (For the proof see Euclid IV, 10). Fig. 6 also shows Euclid's method of inscribing the triangle ACD "equiangular with a given triangle," KLT, Fig. 7 (Euclid IV, 2). It will be noted that the addition of the dotted line BE in Fig. 6 completes the pentagram (star), the symbol of the Pythagoreans, from which some scholars in the history of mathematics infer that this method of constructing the regular pentagon is much older than Euclid (300 B. C.) and is perhaps a product of the school of Pythagorus (about 550 B. C.).

If the historical presentation of these two problems has been of interest to you and you would thus like to continue the story, and, perchance, find more interesting problems, let me suggest the following three sources:

(1) L. C. Karpinski—Robert of Chester's Latin Translation of the Algebra of Al-Khowarizmi, Macmillan, 1915.

(2) T. L. Heath—The Thirteen Books of Euclid's Elements, 3 vols., Cambridge University Press, Macmillan, 1926.

(3) Johannes Tropfke—Geschichte der Elementar—Mathematick in Systematischer Darstellung, 7 vols., Berlin, Walter de Gruyter & Co., 1921-1924.

ELABORATE BURIAL IN INDIANA MOUND.

An Indian mound containing burials of a most elaborate type has just been opened up at Winchester, Indiana, by F. M. Setzler, operating under the auspices of the Indiana Historical Bureau and the Smithsonian Institution of Washington, D. C. The skeleton found beneath the earthwork must have belonged to a mighty chief, for the mound raised in his honor was 80 feet in diameter and eight feet high. It was surrounded by an earthwork enclosing 31 acres of land.

Near the center of the mound was a large area containing raw ochre and partly decomposed bark. In the center of this area was a pit, where offerings of material comfort for the spirit of the departed had evidently been made. There were numerous cremated bird bones, two ceremonial spear points, and two gorgets or throat ornaments, one of slate and the other of sandstone.

Three feet beneath the sacrificial pit in the bark and ochre layer lay the bones of the departed warrior, a man of middle age when he died. Along with the skeleton was an extra skull, badly crushed. Mr. Setzler conjectures that this was possibly added for some ceremonial reason. The bones rested on bark, and had apparently been bark-covered when interred. At the east end of the burial there were six post holes in the ground, indications possibly of a wooden structure since fallen into decay.

To the west of the burial is a stone wall, which has not yet been opened. Mr. Setzler believes that this may conceal more skeletons, which further digging will bring to light.—*Science News-Letter.*

BACKGROUND AND FOREGROUND OF GENERAL SCIENCE.

No. V—Earth Knowledge.

By Wm. T. Skilling,

State Teachers' College, San Diego, Calif.

In article No. III of this series, published in May, 1929, the earth was considered in its relation to the (other) heavenly bodies. Most teachers will agree that the portion of general science drawn from the science of astronomy makes a stronger appeal to the interest of pupils than any other part of the subject. But when interest in earth study has been aroused by considering the earth as related to the sun, moon and planets this interest may be used on which to float a few further lessons dealing with other facts about the particular planet upon which man lives.

The following questions are such as to appeal to either young or old as of fundamental importance. What is the earth made of? What does it weigh? What shape is it? How large? Is it stationary or in motion?

It matters little where we begin, but suppose for problem one we take the question, "Of what is the earth made?" Is a complete answer found in the words "Little drops of water, little grains of sand"?

To prove that these words contain more truth than might appear at first thought provide yourself with a compound microscope from the nearest high school laboratory and show the pupils a pinch of ordinary garden soil under the two thirds inch objective lens. Not only is the soil seen to be nearly all sand, but the sand is nearly all quartz particles.

Discuss, and investigate with a shovel or at road cuts the depth of the soil, and find what lies below the few inches or few feet of fertile surface. Road cut observations will lead to a discussion of stratification and its history.

But what lies below the stratified rock? Observation of pupils who have been in the mountains on a summer vacation may furnish some information about granite, samples of which can also be shown. Below the "dirt" or soil, and the stratified rock lies the rock which has once been melted (igneous), much of which is granite.

It is estimated that to a depth of about forty miles the surface of the continents is composed of rock similar to granite. It contains a great deal of those elements that make up our

most common mineral, quartz. Indeed about three quarters of the whole surface of the earth is made up of the two elements silicon and oxygen, found in quartz. Rock containing much quartz, as granite does, is said to be "granitic." So it may be said that the first forty miles of the earth's surface is, if not actually granite, at least granitic.

But below the granite what? As cream floats upon milk so granite rock floats upon a heavier rock below. Out of the deep volcanoes of the Mid Pacific Ocean comes a heavy, dark colored lava called basalt. Its weight and dark color are due to the fact that it contains a good deal of iron.

Beyond the first hundred miles or so of depth what is to be found? Even volcanoes refuse to bring up the deeper lying material, so how can we even guess what is there? We get nothing from the stars except light waves but these entering our spectroscopes tell us what the stars are made of. Nothing comes from the deep interior of the earth except earthquake shocks which started on the other side of the world and came through by the shortest possible road. These faint tremblings, entering our delicate seismographs, give hints about the density and composition of the material through which they have passed.

Sound wave, and earthquake shocks, which are much the same, travel at different rates through different substances. Self registering seismographs in many parts of the world give the exact time to a fraction of a second when a given earthquake shock arrived and automatically made its wavy mark upon the revolving cylinder. Piecing together such bits of information received at many widely scattered stations enables the scientist to gain some notion of the earth's deep interior.

From such data it is supposed that at the center of the earth there is a core of iron extending about half way to the surface. Above the iron is the heavy dark colored basaltic rock such as deep volcanoes bring samples of. Perhaps there is a sudden change from iron to rock but some think that outside the iron core rock and iron are mixed, the mixture gradually changing to pure rock as we go up toward the surface.

Such a conception of the earth's interior might seem too fanciful to be credited if based on no other facts than those given by earthquake records. But there are several facts which, though not proofs of the earth's iron core, are like weather vanes pointing in the same direction as the facts gained from earthquake records.

That the earth is magnetic with a north and south pole suggests the presence of iron. That iron is very abundant throughout the universe is indicated by the spectra of sun and stars. A rather convincing bit of evidence is found in the composition of meteors. Many of them are known to be an alloy of about 90% iron and 10% nickel. This fact taken in connection with the planetesimal hypothesis of the formation of the earth makes it seem quite probable that as the earth was built up around an ever enlarging nucleus the heavier materials such as iron would gravitate toward the center.

Finally, the weight of the earth is much greater than would be expected if it were composed all of rock. The density of surface rock is about 2.7 times that of water. The average density is 5.5 times as great as if it were made of water. It used to be thought that possibly this could be accounted for by the tremendous internal pressure, but laboratory experiments do not make it seem probable that rock can be compressed sufficiently to be so heavy. The density of iron is about seven. A surface density of 2.7, and a density of three or four for the deeper lying rocks, together with a density of seven for iron might easily give the earth an average density of 5.5, as such experiments as Heyl's shows that it has.

To learn something by observation of the shape of the earth all children can apply one of the two proofs used by the ancient Greeks, and many of them can apply the other. The earth's shadow falling upon the moon during a lunar eclipse is circular, and since there is a visible lunar eclipse nearly every year all that is necessary for the demonstration is a calendar of eclipses, and an alarm clock.

Incidentally an explanation of the reasons for solar and lunar eclipses should accompany this project.

That the surface of the earth falls below the plane of our horizon may be seen by children living near the ocean or any body of water of at least three or four miles in extent. Even a long straight canal has been utilized for the proof by setting up stakes in the water at distances of a mile or two from the observer, whose eye must of course be at the water level.

It might interest children to know that if a perfectly "level" floor or sidewalk a mile long were laid, one end of it would be eight inches lower than the other as compared with a line of sight across it.

Pupils should learn that if the floor or the water surface were

two miles long it would fall, not *two* times eight inches but the *square of two* times eight inches. Likewise at three miles the fall would be *nine* times eight inches and so on.

A few problems extending this line of arithmetical reasoning will not only give pupils practice in squaring numbers but will show some interesting conclusions. For example, islands at sea would have to be mountains to be seen far away. At 100 miles the mountains would have to reach up nearly 7000 feet to be visible.

Measuring the size of the earth may seem too ambitious a project for general science pupils, but it need be no more difficult than a well played game of marbles, and will perhaps be almost as interesting.

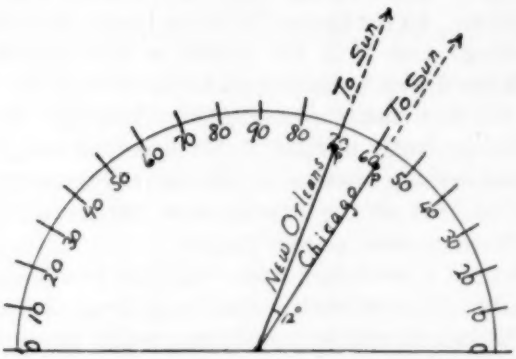
The method of doing this was known to the ancient Greeks, and was first successfully carried out by Eratosthenes about 200 B. C. Eratosthenes lived in the Greek city of Alexandria in northern Africa, a city which in his time was the chief seat of learning.

About 500 miles to the south of Alexandria was another city called Syene situated near where the great Assouan Dam is now located. Eratosthenes knew that in Syene at the time of the summer solstice (June 21) the sun at noon shone directly down onto the water in a well of that town. At Alexandria he found that on the same day at noon the sun's rays came down at an angle of about 7°. He knew that the reason for this must be that the line on the earth's surface joining Syene at the South and Alexandria at the North must curve seven degrees. That is, this 500 mile arc of the earth's circumference is an arc of about 7°. One degree would be one seventh of the distance between the two cities (about 70 miles) and 360°, or the circumference of the earth would be 360 times this, or about 25,000 miles.

What Eratosthenes did with the instruments of his day young pupils could do now with the help of our nicely made "protractors" for measuring angles, and a map with a scale of miles to measure distance.

Suppose a school in Chicago write to a school in New Orleans requesting them to cooperate in the project. On a given day each school will measure the slant of the sun's rays at noon. These cities being about 12° apart in latitude the difference in the slant of the rays at the two places would be 12°, an angle large enough to measure with considerable accuracy. The map with its scale of miles shows the difference in latitude to be

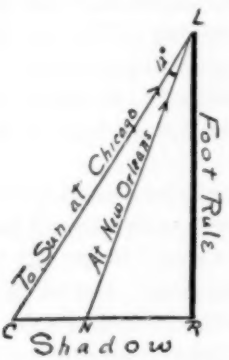
rather more than 800 miles. This makes each degree nearly 70 miles and the earth's circumference approximately correct.



SHOWING THE SLANT AT WHICH THE SUN'S RAYS FALL ON THE SAME DAY AT CHICAGO AND NEW ORLEANS.

To use a protractor in finding the slope of the sun's rays at noon paste a piece of white paper over one side of the protractor to give a surface on which a shadow will be visible. Then just at noon by the sun set the protractor north and south on a flat surface with the straight side down.

Hold a pin or a toothpick against the curved edge as at P in the diagram so that its shadow will fall across the paper to the center at O. The actual angle will depend upon the time of year, but the difference of the two readings at New Orleans and Chicago will always be 12°.



SHOWING THE RELATIVE LENGTHS OF SHADOWS; CR AT CHICAGO, AND NR AT NEW ORLEANS. THE ANGLE CLN GIVES THE DIFFERENCE IN LATITUDE.

The two observing stations should for convenience be as nearly as possible in the same north and south line, but this is not necessary so long as the distance in miles is the distance that

one station is north of the other, not their actual distance apart.

Instead of using protractors to get the slope of the sun's rays a foot rule may be used and the length of its shadow measured at the two stations. In the figure C R is the length of shadow of the rule at Chicago and N R the length of the shadow at New Orleans. When drawn to scale angle CLN which is the difference in slope of the rays should measure 12°. Note that the foot rule must be held perfectly upright to get a correct result.

For demonstrating motion of the earth Foucault's classical experiment in 1851 at the Pantheon in Paris can be repeated more simply than most people imagine.

Foucault used a pendulum more than 200 feet long, but good results can be obtained with a ball hung from the schoolroom ceiling. The ball should be round, and weigh as much as forty pounds. To support so heavy a weight a piano wire is advisable.

The chief danger of failure with the pendulum lies in the method by which the wire is attached at the top. A simple and successful method is to thread the wire through as small a hole as possible in a hardwood board, and then fasten the board firmly to the ceiling with screws.

A six inch lead ball is easily cast at a foundry or in a manual training shop. An eyebolt or a hook must be cast into one side of the ball for a point of attachment.

With a steady hand and a little practice the pendulum can be drawn back and released so carefully that it will follow a chalk line on the floor under it. Within ten or fifteen minutes a very perceptible change will be noticed in the direction of its swing.

The amount that such a pendulum should deviate to the right in an hour may be found by multiplying 15° by the sine of the observer's latitude. This will be found to give about 11° for the Northern part of the United States and 7° for the Southern part. At the Pole it would, of course, turn 15° an hour and not at all at the Equator.

To show that a pendulum will continue swinging in one plane hang a weight from a supporting frame, a ring-stand for example, standing at the center of a small table. Turn the table on a vertical axis while the weight is swinging. The table represents a floor at one of the Poles of the earth, which would, of course, turn all the way round in a day. For purposes of explanation a pendulum at the pole is the simplest case of this experiment.

Swinging a pendulum over a revolving table is necessary to show that such a pendulum would not turn with the earth.

OBJECTIVES AS AIDS IN THE CHOICE OF SUBJECT MATTER IN HIGH SCHOOL CHEMISTRY[1].

By Earl W. Phelan and Catherine S. Rose,

Western Reserve University, Cleveland, Ohio.

In an attempt to crystallize opinion, the Division of Chemical Education of the Americal Chemical Society held a Symposium on Aims and Objectives[2] at the Los Angeles meeting in 1925. Evidently even this failed to settle the matter in the minds of teachers, as we still find lists of objectives being proposed by prominent educators. What help, however, do they offer the beginning teacher? A recent survey of the chemistry teachers of Ohio by the senior author showed that twenty-five per cent of those replying were engaged in their first year of teaching the subject. The totally inexperienced teacher therefore represents an important fraction of the total number of chemistry teachers. Practically every one of these had at least one other subject to teach. Under such conditions, the novice finds a staggering number of problems facing him at the start of the year. It is natural that he looks to some one in authority to tell him what should be the desirable outcomes of the chemistry course, and what material should be taught in order to achieve these results. Instead of agreement of authority, however, he finds a wealth of conflicting suggestions, and delightfully vague statements that chemistry should "help to make the students better citizens."

Once he has waded in and selected a set of aims and objectives which seems workable, he still has to decide what subject matter will best lead in the direction of these aims. Since many states have published syllabi, and the Americal Chemical Society has brought forth a suggested minimum course,[3] the usual procedure is to accept ready-made some standard course and to follow it. The purpose of the present paper is to formulate objectives from the point of view of the novice teacher in terms of their direct and immediate applicability to the problem of choice of syllabus, and to direct attention to a syllabus, differing distinctly in method of approach and emphasis from the classic course inherited from the introductory college course, but satisfying admirably the needs and desires of the ordinary high-school student.

[1]Read before the Division of Chemical Education, American Chemical Society, at Minneapolis, Sept. 10, 1929.
[2]J. Chem. Ed., *2*, 971-997 (1925).
[3]J. Chem. Ed., *1*, 87 (1924).

The following objectives were chosen, not by the oracle, the teacher of long experience, but by the senior author's students, a group of undergraduates preparing to teach chemistry, as offering the most definite and tangible goal.

(1) To develop a real interest in chemistry through class and laboratory work.

(2) To give the student a broader, fuller conception of his environment, and of the laws of nature.

(3) To give the student an understanding of the importance of chemistry in all life, so that as an adult he will support intelligently, rather than hinder, the chemist.

(4) To make the student able to judge more intelligently concerning public problems such as water purification, and private ones such as use of medicines, sanitation, health, choice and use of foods, and industrial processes and products of which he is the ultimate consumer.

(5) To give a knowledge of fundamental facts and principles thorough enough to allow understanding the topics discussed in pursuit of the above aims, and incidentally to prepare for college entrance examinations.

(6) To develop, through a study of the methods of scientists and actual applications of these methods in the laboratory, the scientific attitude of experimentation and weighing and sifting of facts.

(7) To enable the student to read with greater interest and fuller understanding articles about science in newspapers and journals.

(8) To give the student contact with the materials and methods of chemical investigation in the laboratory, so making his interest more personal.

(9) To give some training in manipulation of apparatus, with emphasis on neatness, accuracy, and care.

(10) To provide opportunities for the development of the interest and ability of the student who shows a decided interest and aptitude for chemistry.

Even if these aims are achieved only partially, the student will have gained far more than if he had devoted twice as much time to memorizing a large number of facts for the sole purpose of passing the course. The aims given above throw most of the emphasis on interest in, and attitude toward, the science, and these will long outlive facts learned, particularly when these facts are not correlated with life.

In spite of recent efforts to correct this tendency, most of the published syllabi show regrettable copying of the general features of introductory college courses, with resulting duplication of effort for those who go to college. The ready-made course which starts out in a different direction from these, and promises best toward achievement of the aims listed above is the "Syllabus in Applied Chemistry" issued as one of two alternative courses by the State of New York.[4]

This outline is of great value to the beginner in the teaching of chemistry, as it gives a definite, logical arrangement of topics instead of merely listing the minimum essentials and leaving decoration and order of development to the teacher. The American Chemical Society outline merely tabulates in alphabetical order at the end the supplementary topics such as adhesives, artificial stone, beverages, cleansing agents, etc., which really motivate and vitalize the work. They are thus apt to be largely subordinated to the more theoretical considerations.

By contrast with the traditional type of course, the applied chemistry course is made up under the following few required topics.

1. The work of the chemist: making new things, improving of old, finding what substances are made of.
2. Matter. Mass. Molecules.
3. Decomposition of some substances.
4. Chemical compounds and mixtures.
5. Water, the most useful solvent.
6. The law of definite proportions.
7. The atmosphere, burning and fuels.
8. Symbols. Valence and formula-writing.
9. Acids, bases, salts, hydrolysis.
10. Simple equations and weight problems.
11. Metals, their uses and extraction, corrosion.

This list of required topics seems at first the start of the old favorite. The difference is in the manner of development, which is based upon the student's daily experience, and which must be studied in detail for adequate comprehension. A large number of optional subjects is given, to allow variation to fit the needs of different types of students, but with the general advantage that the method of presentation is always suggested.

This sort of course, modified necessarily for students of differ-

[4]Syllabuses in Physics and Chemistry. Bull. 853, the University of the State of New York, Albany, New York.

ing localities, should give those who study it a far better realization of chemistry than the other type. Some of the advantages it offers in realizing the aims listed previously are given below.

(1) The introduction to the work of the chemist arouses interest and gives an idea at the beginning of the course as to what chemistry is, what it does, and what it can do for the development of civilization.

(2) Throughout the course interest is maintained and work motivated through the use of material from the student's environment.

(3) Knowledge of this material from their environment, and use of it in study of theory makes transfer of learning more possible. Modern psychology teaches that there is little transfer unless some element of attitude or method is identical. Too often in the traditional course the student is unable to apply knowledge or any skill in manipulation or habits of accuracy to problems outside the laboratory. In this course the knowledge and skill are acquired in situations more nearly approaching the situations where they may be applied in real life.

(4) This course lends itself more easily to the use in class of current scientific material, the history of science, and the lives of scientists, since there are fewer facts arbitrarily set to be learned. By this material the student is interested and inspired, and its use in class will encourage use of it in later life.

(5) The "scientific attitude" may be acquired better through a study of scientists and solution of problems in the laboratory somewhat like those to be solved outside.

(6) All the really essential fundamental theory of chemistry is contained under the required topics. What has been omitted is a detailed study of many compounds and elements outside the student's range of interest, usually learned to be forgotten, and the more complex theories, laws, and problems. The theoretical basis is sufficient to serve as a background for a study of the practical applications, and also as a valuable preparation for the college course, should the latter be taken.

(7) There is ample opportunity for satisfying individual needs. The optional topics need not all be studied by all the students. The better students may be rewarded by introduction to more of the optional subjects. This flexibility is recognized as a great assistance to the teacher.

A course which gives the chief laws and natural facts on which the science of chemistry is based, and then devotes a large por-

tion of the time to what chemistry is doing in the world of the student should interest him more, and so he better remembered and applied after school is over. Even if he forgets most of what he learns, his reaction to the word "chemistry" will not be antagonistic, and he will support chemistry and the chemist.

PROBLEMS OF INSTINCT AND INTELLIGENCE[1]—A BOOK REVIEW.[2]

By Margaret Blossom.

To review this book in the sense of passing judgment on its scientific accuracy would be presumptuous for any but an expert of high rank. Major Hingston is the author of two earlier works —*A Naturalist in Himalaya* and *A Naturalist in India*. These, and the wealth of observation and experiment which he has brought to the support of this thesis on the relation of instinct and intelligence must establish his claim to a hearing even though psychologists may make of his deductions the controversy that he himself anticipates.

"How far are animals mere machines; how far do they think in a manner like ourselves?" Thus he puts in a sentence the plan of his book. It is of absorbing interest. To present a digest of it for the pleasure of those who might not otherwise know it is all that this paper can attempt to do.

Since the first necessity is to agree on terms, our author sets before us his use of the word "instinct." No dictionary meaning satisfies him. "It graduates at one extreme into intelligence, at the other into unconscious reflex action. . . . It is independent of instruction, unassociated with any reasoning, ignorant of the end." Thus he describes what to him is "undefinable."

Spiders and insects furnish the material for his study, which gives special attention to the wasps, ants and beetles. In five chapters he sets forth with varied and vivid detail the familiar evidence for the power of instinct: its "inflexibility," "rhythm," "wisdom," "folly," "limitation." The case is made strong for instinct as a ruling force in the insect world; the conventional viewpoint is as well sustained as if there only lay the author's interest.

But now come the modifications: (1) Instincts are variable,

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[1]Written by Major R. W. G. Hingston, M. C.; published by The Macmillan Company, 1929.

[2]This article was prepared in Dr. Otis W. Caldwell's class on "Principles of Science in Secondary Schools." It is presented here as a very interesting report on a new book and as a suggestion to science teachers for the effective use of supplementary reading.—Ed.

as in a caterpillar which builds a coccoon or not according as it finds itself on leaves or on the ground when ready to pupate. If on the ground it buries itself and pupates naked. A widely distributed harvesting wasp (*messor barborus*) works early in the day, late in the day, or all day long, varying its habits in accordance with the climate and district: desert, or mountains, or the Mediterranean coast. (2) Instincts are often in error too. A spider was observed to drag an empty snail shell in place of her egg sac. The flesh-fly frequently lays her eggs on the carrion flower instead of the usual carrion—an obvious error fatal to the young. A boring caterpillar pupates in fruit, but leaves so small an entrance hole that 70 to 90% of the moths die imprisoned.

The great interest of the book is its record of actions that can hardly be interpreted otherwise than as showing reason and forethought. The reasoning is often rudimentary; but many times it is involved, and with claims to being called highly intelligent. To quote only a few examples: Ants entering a house by the window were blocked by a sheet of sticky fly-paper and seemed to retreat. But back they came with bits of sand and wood and built a roadway over which they passed.

Another swarm of ants, crossing a car-line, were crushed to the number of thousands. Then they tunneled under the rails, and when Major Hingston destroyed the tunnel they dug another and went on their way.

Other ants were digging a nest in a sandy bank and as they brought out each load they slipped and rolled with the crumbling sand to the bottom. An ant-engineer began tugging pebbles up the slope till, with hours of labor, it built a platform on which the diggers could stand safely to dump their loads.

Most curious is the habit of certain ants—the Red Tropical Tree Ant, *Ecophylla smarogdina*, which makes nests among the leaves. Not only do they draw the leaves together by bridging the gap with their bodies—one, two or more as the space varies from petioles to tips—but, having worked and pulled till one ant at each point on the leaf margin suffices to hold the leaves, a larva is brought in the arms of a worker and back and forth it is moved, the spinnerets touching now one leaf and now the next, till a solid bank of silk holds them in place and the ants may be released from their bridging, pulling task.

Adding to his own observations on acts of seeming intelligence performed by wasps he quotes from "such distinguished observ-

ers" as the Peckhams: the story of the wasp that used a pebble as a hammer to pound the dirt into its hole; another that brought home a huge spider, certainly too large for the door of the nest. Did the wasp, like others, try to get it in? The answer is all but incredible: the wasp dropped its prey at a little distance, carefully surveyed the hole, returned to the spider for an equally careful survey, then set to work to enlarge the hole. And on the first trial the spider passed the doorway!

At what age, one is tempted to ask, would a child have done as well? And what observer would refuse it the credit of an intelligent act?

Space is lacking to quote instances of memory among the various insects: memory of places and of home environment, which Major Hingston tests as he might test the memory of a child. His verdict is that "the mental operation employed by these insects is essentially the same as that used by man."

It must be understood that the acts of reason are few compared to the mass of instincts. The mechanism in the lower forms is predominant, as reason and habit are predominant with us. To Major Hingston these few acts of reason in the insect world furnish the clew to the origin of instincts.

At first all was reason—primitive, imperfect, often failing. By natural selection the nervous mechanism behind the successful acts of reason became fixed as hereditary. The acts in consequence became more fixed, and at last the perfection of the process resulted in automatism for all the essential acts of life. So habits may be inherited, says Darwin, and habits he finds often indistinguishable from instincts.

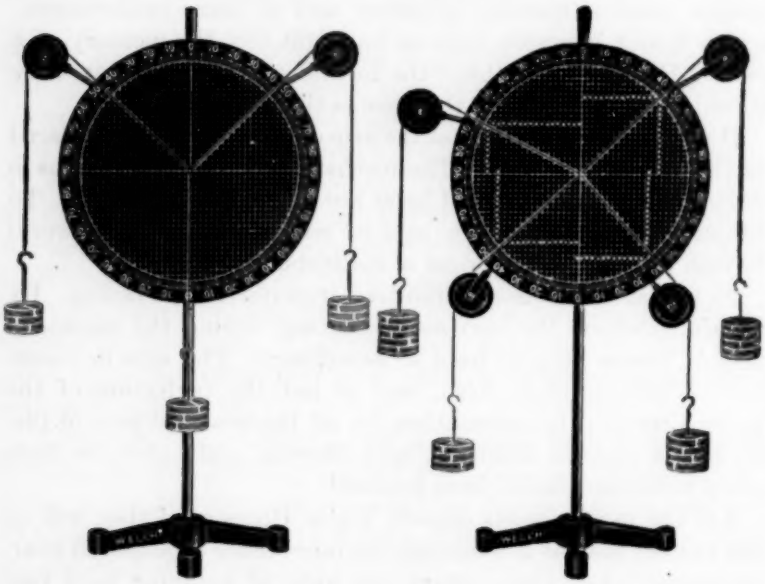
Let the psychologists dispute Major Hingston if they will on the ground that he is assuming the inheritance of acquired characteristics. Let them attack the logic of applying to a race psychological development as we see it in our individual selves. Our author has asked: "How far do the animals think like ourselves" and his conclusions are to him in harmony with the unity of a life process, "with those laws of continuity which, as our knowledge of the world grows, become more and more firmly established."

Whatever the verdict on the relation between instinct and intelligence, every reader of the book will carry away with him the hope of finding for himself an insect carrying out an act of intelligent planning, showing the foresight and calculation in which Major Hingston has forced us to believe.

A FORCE TABLE WITH NEW FEATURES.

By W. L. Kennon,
University of Mississippi, University, Miss.

The fundamental importance of experiments illustrating the composition and resolution of three or more forces acting at a point demands the inclusion of such experiments even in the most elementary laboratory courses in Physics. To present clearly to beginning students the vector aspect of such force actions (which is the very heart of these experiments) as well as to show plainly the physical circumstances of the experiment, requires special attention to the laboratory set up.



The form of apparatus* illustrated is an attempt to meet these requirements. The unique feature of the apparatus is the use of the "unit circle" accurately provided with vertical and horizontal coordinates, together with an angular scale. For example, referring to the arrangement shown with three forces, it is at once obvious to the student that the central weight is being supported by the two outside weights, yet it is likewise evident, from the respective values of these weights, that only "parts" of the latter are required to counterpoise the former. The concept of vertical and horizontal components arises therefore in a

*Manufactured by the W. M. Welch Scientific Company, Chicago.

perfectly logical way. The numerical values of these components may then be determined readily with the aid of the coordinate system, and their algebraic equality along the vertical and horizontal axes accurately tested without recourse to mathematical tables or other indirect means. The arrangement incidentally provides a simple and effective means of teaching angular functions for future laboratory use.

The vertical form has been adopted, because in this form the adjustments and values may be observed more readily. Especially is this the case when a group of students is observing the same experiment, as in a class demonstration. It is quite obvious, also, in the vertical arrangement that the several forces are acting in the same plane and that they have their origin in the weights of the suspended bodies. Again the vertical form renders the apparatus less cumbersome to store without dismantling.

Other features of the special design shown are its experimental flexibility, substantial construction, and freedom of friction. The twelve inch disk provides ample space for the coordinate divisions without crowding. The pulley rods are mounted in universal clamps provided with spring washers that ensure easy and accurate adjustment of the angles. The outfit may be dismantled readily and the parts used in connection with other experiments.

ACIDS FROM SAWDUST.

Indications of a possible future use for the sawdust that now makes useless and troublesome mountains around sawmills were contained in a paper by Prof. W. H. Peterson, R. J. Allgeier and Prof. E. B. Fred of the University of Wisconsin. In a cooperative chemical-bacteriological research program, they have discovered how to make the powdery wood waste into acetic acid, the active principle of vinegar, and lactic acid, which is what makes sour milk sour. Both these acids have industrial uses that render their domestic significance an entirely secondary matter.

Three steps were involved in turning wood into acid. The first was turning it into sugar, which was done by the old familiar method of treating it with a strong chemical, such as sulphuric or hydrochloric acid. Then the pulp was further treated with a carbohydrate-converting enzyme, contained in malt sprouts. Finally, the process was completed by the addition of a microorganism that has the power to ferment both hexose and pentose sugars into acid.

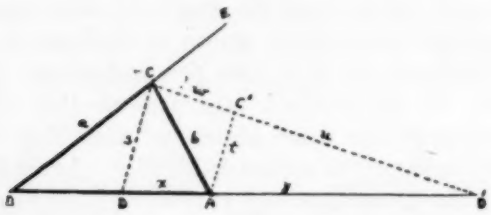
From 80 to 90 per cent of the sugar present was fermented, the resulting mixture of acids consisting of ten parts of lactic to one of acetic. Wood sugar produced by the Bergius process in Germany fermented equally well and gave the same yield and ratio of products.—*Science News-Letter.*

A PROOF OF THE LAW OF TANGENTS.

By J. S. Georges,

The University of Chicago High School.

The following proof of the law of tangents may be of interest to the teachers of trigonometry because of its simplicity. It is based upon the harmonic division of a line segment.



Let CD and CD′ bisect ∠ACB and ∠ACE respectively, and draw AC′ parallel to CD. Then in the figure, since AB is divided harmonically at D and D′, we have

$$\frac{x}{y}=\frac{a-b}{a+b} \qquad (1).$$

Also, since CD is perpendicular to CD′, we have

$$\frac{x}{y}=\frac{w}{u} \qquad (2),$$

and

$$\frac{s}{w+u}=\frac{t}{u} \qquad (3).$$

Dividing (3) by t/w we have

$$\frac{\frac{s}{w+u}}{\frac{t}{w}}=\frac{w}{u} \qquad (4).$$

From (1), (2) and (4) we obtain

$$\frac{\frac{s}{w+u}}{\frac{t}{w}}=\frac{a-b,}{a+b,'}$$

or, since $\angle ACC'=\frac{1}{2}(A+B)$, and $\angle CD'D=\frac{1}{2}(A-B)$

$$\frac{\tan \frac{1}{2}(A-B)}{\tan \frac{1}{2}(A+B)}=\frac{a-b}{a+b}.$$

WHAT TEST SHOULD I USE?

By Marion E. Haskell and Earl Hudelson,

University of Minnesota.

Every day the disillusionment goes on. Yesterday's experience will serve as well as any.

A science teacher came into the office and said, "I want to test my pupils. What test should I use?"

"What do you want to test them on?", we asked.

"Science."

"What part of science?"

"Well—general science?"

"What part of general science?"

"Why—all of it, I guess."

"We are sorry," we tell him, "but there is no single test and no combination of tests that measure either knowledge of or ability in all general science. If there are particular abilities which you wish to measure we may be able to recommend a test. Suppose you break your general science course down into the specific knowledges and abilities and attitudes which you are trying to teach; then we shall examine together the available tests to see whether any of them will meet your needs."

The following pages illustrate one such attempt with the unit on Health. On the left are listed the knowledges, skills, and dispositions striven for in the course. Opposite each item is a check mark under each available general science test which tests that item. [Sample pages only of the check sheets are shown here. For the remainder of the list the numbers of the tests, according to the sample, which were checked are given in italics.—Editor.]

The outstanding condition revealed by this analysis is the preponderance of blank spaces. Only one of the tests is at all adequate for measuring accomplishment and none is complete enough for diagnostic purposes. The general science teacher who wishes to measure his pupils diagnostically will have to supplement the existing instruments with many items of his own. This may be in no sense a reflection upon the existing tests; but it does illuminate a situation that should be realized.

HEALTH.

Aim.

To secure maximum physical efficiency through the knowledge and application of the principles included in health instruction. To obtain this aim the following abilities are to be developed:

I. Ability to make one's food contribute in maximum measure to one's physical welfare.
  A. Ability to understand that different classes of foods are composed of varying elements.....
    1. Ability to differentiate between the action of the organic and inorganic substances.
      a. Ability to understand that the action of inorganic material may be either as activators or as regulators.
        (1) That activators are certain salts.
        (2) That regulators are other elements.
        (3) That water is necessary to all cells.
      b. Ability to understand that the organic substances are grouped into different classes according to the elements that they contain.
        (1) Carbohydrates are composed of carbon, oxygen and hydrogen.....
        (2) Proten has the additional element of nitrogen.....
        (3) Fats and oils have a large proportion of carbon and a small proportion of oxygen.....
  B. Ability to see the need of the body for each class of food substance.
    1. Ability to connect any class of food with its function to the body.
      a. Ability to know the action of every cell.
      b. Ability to visualize each body function.
    2. Ability to learn that
      a. Carbohydrates furnish fuel and fat tissue.....
      b. Proteins furnish materials resulting either in the growth or repair of the cell.....
      c. Fats and oils furnish fuel and fat tissue.....
  C. Ability to classify common foods under nutritive headings.....
    1. Ability to find out the chemical constituents.....
      a. Ability to use tables of food contituents.
  D. Ability to make one's dietary balanced.
    1. Ability to comprehend the meaning of a balanced ratio.....
      a. Ability to understand division of numbers.
      b. Ability to understand how this can apply to food substances....
    2. Ability to apply the ratio of a balanced diet to each meal.
      a. Ability to select foods that conform to this ratio.....
        (1) Ability to translate the products of the factory and kitchen into terms of proteins and calories.....
          (a) Ability to use calorie table.....
          (b) Ability to change amounts of the tables into amounts to be consumed.
    3. Ability to determine the standard diet for the individual.
      a. Ability to consider.
        (1) Age of the individual.
        (2) Amount and character of the individual's work.
        (3) The season of the year.
      b. Ability to cope with any reasons for irregularity.
    4. Ability to eliminate from one's diet the foods that are of no benefit or positively harmful.
      a. Ability to substitute.
      b. Ability to exercise self control.
  E. Ability to understand the significance of treating certain foods.
    1. Ability to select foods that require cooking.
      a. Ability to understand the reasons for cooking these foods.
        (1) Cooking breaks up and softens the cell membrane.....
        (2) Cooking produces certain chemical changes to render the food more digestible.....

I	II	III	IV	V	VI	VII	VIII	IX
Dvorak—General Science Scales	Downing—Range of Information Test in Science	Giles, Thomas, Schmidt—General Science Examination	Pieper and Beauchamp—Tests on Everyday Problems in Science	Powers—General Science Test	Rush and Popenoe—General Science Test	Toops—General Science Test	Coopridder — Information Exercises in Biology	Rush and Coxman—Biology Test
	✓							
✓		✓			✓		✓	✓
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(3) The action of heat upon starch grains results in the breaking up of the grain.
(4) Cooking has the effect of destroying many harmful bacteria *(III)*
b. Ability to see the significance of eating some raw food.
(1) Cooking certain vegetables results in the loss of some of the nutrition. *(III)*
c. Ability to see why some hard foods should be eaten.
(1) Exercises the gums.
(2) Acts as roughage.

F. Ability to see that foods are not destroyed by bacteria.
1. Ability to understand the fact that certain foods are rendered unfit for use without any visible signs. *(III)*
2. Ability to understand the means of keeping foods.
a. Ability to realize the action of varying temperatures. *(I)*
(1) Excess heat will destroy some bacteria. *(III)*
(2) Extreme cold will destroy others. *(III)*
(3) Extremes will prevent them from multiplying.
b. Ability to understand other ways of preventing decay.
(1) Brine Solution. *(III)*
(2) Sugar solution
(3) Drying.

G. Ability to guard against harmful adulteration in foods.
1. Ability to learn the common means of adulterating foods. *(III)*
2. Ability to recognize the evidences of these adulterations. *(III)*
3. Ability to distinguish which are poisonous from which are only of inferior material. *(III)*

H. Ability to learn certain rules of the hygiene of eating.

I. Ability to apply the rules of the hygiene of eating.
1. Ability to keep in the right mental attitude at the time of eating.
a. Ability and disposition to suppress anger.
b. Ability and disposition to keep from getting too excited or from any intense emotion.
c. Ability to refrain from hurry while eating.
2. Ability to know when to eat.
a. Ability to maintain regularity.
(1) Ability to refrain from eating between meals.
b. Ability to select a time when there will be no feeling of strain.
3. Ability to know when to stop eating.
a. Ability to determine when one has eaten a sufficient amount to satisfy the body needs.
b. Ability to exercise self control after that amount has been consumed.
4. Ability to realize the necessity of drinking water with meals.
a. To drink enough.
b. To drink slowly.
c. To refrain from "washing down "food with water.
5. Ability and disposition to give attention to the mechanics of eating.
a. To chew food sufficiently. *(III)*
b. To eat slowly.
c. Not to go to extremes in "a" and "b."
6. Ability to see relationship of exercise to the digestion of food.
a. To refrain from exercising directly after meals.
b. To understand the need for exercise in cell activity.
(1) Ability to understand how the cell receives its supply of oxygen.
(2) Ability to understand how the cell receives its supply of food.
(3) Ability to understand the process of digestion. *(III)*
(4) Ability to understand the process of absorption. *(III)*
(a) Ability to sense the part the blood plays in this process. Ability to see that exercise makes blood circulate more rapidly.

(5) Ability to understand the process of assimilation. *(III)*
c. Ability to select the right kind of exercise for this need.
(1) To differentiate between the involuntary and voluntary muscles.
(2) To exercise so as to contribute to the action of the involuntary muscles.
(a) The involuntary muscles must be kept in good muscle tone for digestion.
7. Ability to avoid constipation.
a. Ability to recognize the symptoms.
(1) Headaches.
(2) Drowsiness.
(3) Tired feeling when the amount of work done does not warrant it.
(4) Loss of appetite and indigestion.
(5) A coated or "furry" tongue.

II. Ability to make one's muscular activity contribute to one's health.
A. Ability to employ setting-up exercises for corrective purposes.
1. Ability to determine the kind of exercise needed.
a. Ability to know the different exercises affecting the various organs.
b. Ability to know the different exercises affecting the various bodily functions.
2. Ability to understand the relationship between exercises and bodily activity.
a. Ability to understand how exercise speeds up circulation.
b. Ability to understand how exercise effects respiration.
(1) Ability to understand the mechanism of respiration.
(2) Ability to understand the capacity of lungs.
c. Ability to understand how exercise keeps the body at the correct temperature.
(1) Ability to comprehend the reason for the maintenance of a constant temperature.
d. Ability to understand effect indigestion.
e. Ability to understand effect on nervous system.
3. Ability and disposition to fix a definite time for exercise.
a. Ability to determine the best time for the individual.
b. Ability to determine the length of time to devoteto each exercise.
4. Ability to control one's activities so that a specific time can be devoted to "set-ups."
5. Ability to keep at an exercise until results are obtained.
6. Ability and disposition to put one's self in the frame of mind to make the exercising pleasurable.
7. Ability to get all contributing factors right.
a. Temperature of the room.
(1) Ability to learn correct temperature.
(2) Ability to read thermometer.
b. Freedom of body from hampering clothes.
B. Ability and disposition to engage in some worthwhile kind of exercise that is not formal.
1. Ability to select what one would enjoy.
a. Ability to try out several kinds of exercises.
2. Ability to obtain the necessary skills for enjoyment.
3. Disposition to grasp every opportunity for the performance of this activity.
4. Ability to refrain from over fatigue.
a. Ability to determine proper balance between rest and exercise.
b. Ability to determine when one is fatigued.
c. Ability to stop when that state has been reached.
C. Ability to maintain posture that is conducive to the best physical functioning.
1. Ability to learn the rules for good posture.
2. Ability to understand the reasons for these rules.

a. Ability to see the relationship between the rules and each activity.
b. Ability to visualize the results of not abiding by these rules.
3. Ability to apply the rules of good posture.
a. Ability to sit correctly.
b. Ability to stand correctly.
c. Ability to walk correctly.
d. Ability to act at all times with ease.

III. Ability to make one's sleep contribute in maximum measure to one's efficiency.
A. Ability to secure proper ventilation.
1. Ability to understand the rules for proper ventilation.
a. Ability to understand that air is not a simple substance.
(1) Ability to differentiate between action of oxygen and carbon dioxide. *(VIII)*
b. Ability to appreciate that waste products are given off into the air.
c. Ability to understand that air has motion.
d. Ability to understand that warm air rises.
e. Ability to understand that cold air settles.
2. Ability to recognize the need for proper ventilation.
a. Ability to see the need of the body for oxygen.
(1) Ability to understand the respiration of each cell.
b. Ability to see the need of eliminating carbon dioxide from the body.
(1) Ability to understand the action of waste gases.
c. Ability to recognize the need of eliminating other wastes.
d. Ability to appreciate that without fresh air these wastes can not be eliminated.
3. Ability to apply the rules of proper ventilation.
a. Ability to select the right windows to open to obtain the most air.
b. Ability to eliminate drafts.
c. Ability to regulate temperature of the room.
B. Ability to determine the number of hours of sleep needed by the individual.
1. Ability to arrive at a subjective rating of how one feels after varied number of hours of sleep.
C. Ability to control factors so that the required number of hours is obtained.
1. Ability to apportion time for recreation.
2. Ability to apportion time for work.
3. Ability to abide by these apportionments.
D. Ability to relax physically.
1. Ability to relax muscles.
E. Ability to relax mentally.
1. Ability to disengage mind from worry.
2. Ability to disengage mind from active thinking.
3. Ability to give one's self over to pleasant thoughts.
F. Ability and disposition to refrain from eating heavy food before retiring.
1. Ability to determine what can be eaten without harmful results.
2. Ability to exercise self control.

IV. Ability to maintain personal cleanliness.
A. Ability to recognize the relationship between personal cleanliness and health.
1. Ability to understand that certain wastes are eliminated through the skin. *(I)*
a. Ability to see the necessity of keeping the pores clean.
2. Ability to understand that water must be eliminated from the skin to regulate the body temperature.
3. Ability to understand that clean teeth are not likely to decay. *(III)*
a. Ability to learn the parts of the teeth.

b. Ability to learn the cause of decay.
c. Ability to see the need of brushing the teeth daily. *(VIII)*
4. Ability to sense the necessity of keeping abrasions clean.
a. Ability to understand that the skin is a means of defense against bacteria. *(III)*
. Ability to apply the principles of cleanliness.
1. Ability to accomplish cleansing of the skin.
a. Ability to understand the means of cleansing.
(1) Warm water.
(2) Pure soap.
b. Ability and disposition to take a bath daily.
(1) Ability to understand why a warm bath is best.
2. Ability to apply the proper antiseptics to abrasions. *(I)*
3. Ability to care for the teeth.
a. Ability to use a tooth brush.
b. Ability to select the right kind of tooth paste.
c. Ability to follow sound directions for brushing the teeth. *(VIII)*
d. Advisability of seeing a dentist every six months at least.
(1) Disposition to go to the dentist oftener if necessary.
e. Determination to refrain from using the teeth as "nut crackers."
4. Ability to keep the hands clean.
a. Ability to understand why the hands should be washed before using them to convey food to the mouth.
b. Disposition to keep hands away from the face when not eating.
c. Obligation to keep hands away from a cut or wound.
5. Ability and disposition to develop health habits of personal cleanliness.
a. Ability to follow the "law of exercise."
b. Ability to keep from allowing one's self to get careless about the rules of health one already knows.
c. Ability to appreciate the dangers of not acquiring good habits.
V. Ability to guard against micro-organisms so as to prevent disease.
A. Ability to protect one's self from attack of micro-organisms.
1. Ability to understand what bacteria are. *(III)*
a. Ability to visualize how small an organism can be.
b. Ability to understand the means of multiplication.
c. Ability to realize the toxic action. *(III)*
2. Ability to understand the ways that bacteria enter the body.
a. A cut in the skin. *(III)*
b. One of the regular openings.
(1) Mouth.
(2) Nose.
3. Ability to recognize and guard against the opportunities for contact with harmful bacteria. *(III)*
a. Certain insects are agents. *(III)*
b. Contaminated food. *(III)*
c. Impure water supply. *(III)*
d. Contact with people or animals that are infected.
4. Ability and disposition to control conditions so as to prevent infection.
a. To eat only pure food.
b. To drink only pure water.
c. To keep an unbroken skin.
d. To use an antiseptic if skin is broken. *(I, III)*
e. To breathe through the nose.
f. To secure proper ventilation.
(1) Ability to understand reason for ventilation.
g. To keep the body clean.
h. To stay away from people who have a disease. *(III)*
i. To stay away from people who have been exposed to a disease.
B. Ability to deal effectively with micro-organisms and their products.
1. Ability to understand the relationship between bacteria and disease.

a. Ability to realize that micro-organisms are every where. *(III)*
(1) Ability to realize that not all micro-organisms are harmful. *(III)*
(2) Ability to realize that even harmful ones are going to get into the body at sometime. *(III)*
b. Ability to understand relationship between bacteria and decay.
(1) Ability to locate examples in the decay of common food stuffs. *(III)*
(2). Ability to connect the decay of body tissues to an action of this kind. *(III)*
(3) Ability to understand that some diseases are caused in this way. *(III)*
c. Ability to understand relationship between micro-organisms and other vital processes.
(1) Ability to see how these organisms can interfere with the circulation of the blood.
(2) Ability to relate the action of the white blood corpuscles to the wellbeing of the tissues. *(V, IX)*
(3) Ability to see how cells may become clogged.
2. Ability to understand the means the body has of combating the harmful organisms.
a. Ability to maintain "Natural Immunity."
(1) Ability to realize that the skin is the first line of defense. *(III)*
(2) Ability to comprehend that the white corpuscles injest the bacteria. *(III)*
(3) Ability to understand that anti-toxin is formed in the blood to combat the bacteria present.
b. Ability to understand "Acquired Immunity."
(1) Ability to understand the process of vaccination. *(III, VI)*
(2) Ability to understand the process of anti-toxin treatment. *(III, V)*
(3) Ability to differentiate between the two. *(III)*
(4) Ability to recognize the need for these two treatments.
(5) Ability to understand the reaction of the body.
(6) Willingness to go to the right person for application of these treatments when necessary.
(7) Ability to appreciate statistics concerning value of vaccination.
C. Ability to control conditions so as to prevent the spread of disease.
1. Willingness to abide by public health laws.
a. Ability to protect others when coughing and sneezing.
b. Ability to read contagion signs.
c. Determination to stay away from people in quarantine.
d. Willingness to keep one's self in quarantine when necessary.
2. Willingness to avoid large gatherings when there is an epidemic.
3. Ability to use disinfectants and antiseptics.
a. Ability to recognize a disinfectant. *(III)*
(1) Ability to apply a disinfectant.
b. Ability to recognize an antiseptic. *(III)*
(1) Ability to apply an antiseptic.
4. Ability to prevent spread of disease by insects.
a. Ability to keep insects away from food.
(1) Ability to screen windows and doors.
(2) Ability to keep all food covered.
(3) Ability to use devices to kill insects. *(III)*
b. Ability to prevent insects from breeding.
(1) Ability to keep surroundings clean.
(2) Ability to prevent breeding in swamps. *(III)*
(a). Ability to drain the swamps. *(III)*
(b) Ability to see that oil is applied.
(3) Ability to see that the garbage is covered.
5. Ability and willingness to cooperate with public agencies.

a. To abide by the physician's decision.
b. To follow the physician's orders.
c. To participate in health campaigns.
d. To read the literature dealing with disease and disease prevention.
e. To cooperate in such enterprises as
(1) Extermination of insects.
(2) Clean-up week.
(3) Removal of wastes.
(4) Licensing of animals.

6. Ability to realize the value of protection by laws.
a. Pure food and drug law.
b. Inspection of meat.
c. Purification of water.

7. Ability and disposition to keep informed as to the discoveries of science in field of prevention of disease.

THE RELATIVE IMPORTANCE OF THE MODERN LANGUAGES FOR THE STUDENT OF SCIENCE.

By Elbert H. Clarke,
Hiram College, Hiram, Ohio.

When one is giving advice to students who expect to be able to read scientific literature in more than one language as to which of the modern foreign languages is likely to be of the greatest service it is sometimes difficult to justify the advice by more than a statement of a personal impression and belief. In order to find a real basis for an appraisal of relative values I collected the titles of 3265 books and papers reviewed, abstracted or mentioned in American and English scientific journals in the year 1928. The results are given as follows:

Language	Number of Titles	%
English	1590	48.7
German	1049	32.1
French	419	12.9
Italian	105	3.2
Spanish	30	0.9
All Others	72	2.2
Total	3265	100.0

These figures would seem to indicate that for the English speaking scientist, German is likely to be two and one-half times as important as French, French is four times as useful as Italian, and that Italian is three and one-half times as important as Spanish. Or putting it on a scale of usefulness where Spanish would rank as 1, Italian ranks 3½, French 14 and German 35.

Of course other factors than the scientific usefulness of a language will help to determine its choice, even for science students, and in some fields of research the relative need of a particular language may be quite different from that noted above.

EFFECTIVE METHODS OF TEACHING SUBTRACTION OF SIGNED NUMBERS.

By Charles A. Stone,

University High School, University of Chicago.

Teachers of mathematics are unanimous in their opinions that the unit involving signed numbers is one of the most difficult for pupils to master. This fact has been verified by a recent investigation[1] which makes a detailed analysis of the learning units of algebra. In this study, it is shown that sign difficulty ranks second in difficulty with a total of 22.9% of all the errors made by pupils on specially prepared algebra tests. In investigating[2] difficulties in algebra, the writer also found the above to be true. Furthermore, he discovered that many difficulties experienced by pupils in algebraic manipulation could be traced to a lack of understanding of the process of subtraction.

Since mastery of the unit involving signed numbers is of great importance as far as success in algebra is concerned, and since subtraction has been found to be the most difficult process in the unit, the writer feels that the teacher should have at his command the very best methods of presenting subtraction of signed numbers.

Thus the purpose of this paper is the presentation of effective methods of teaching subtraction of signed numbers as found in textbooks, magazines, and literature dealing with the teaching of mathematics. The methods are given as follows:

I. A common method of presenting the subtraction of signed numbers is the one involving the use of the number scale.[3] Here the difference between numbers may be found by counting from the subtrahend to the minuend. This is illustrated by the following examples:

(a) From +2 subtract +5.

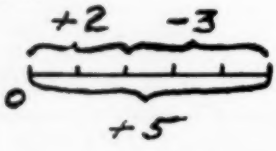


Fig. 1

[1]Pease, Glenn R. "An Analysis of the Learning Units in N-Processes of Algebra." *Mathematics Teacher*, May, 1929.
[2]Waples, Douglas, and Stone, Charles A. "The Teaching Unit." D. Appleton & Co. New York, 1929.
[3]Breslich, E. R. "Junior Mathematics," New York. Macmillan Co., 1929, Book III.

Solution.—On the number scale mark +5 and +2. From +5 count to +2, i.e., count three units to the left. Hence the difference is −3.

Thus $+2-(+5)=-3$
Comparing with $+2+(-5)=-3$
We find $+2-(+5)=+2+(-5)$

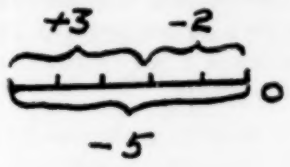


Fig. 2

(b) From −2 subtract −5.

Solution.—As before, mark off −2 and −5. Begin at point −5 and count to −2, i.e., 3 units to the right.

Hence $(-2)-(-5)=+3$
Comparing with $(-2)+(+5)=+3$
We find $(-2)-(-5)=(-2)+(+5)$

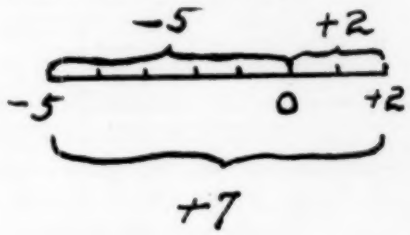


Fig. 3

(c) From +2 subtract −5

Solution.—Beginning at point −5 count 7 units to the right to point +2.

Hence $+2-(-5)=+7$
But $+2+(+5)=+7$
Therefore $+2-(-5)=+2+(+5)$

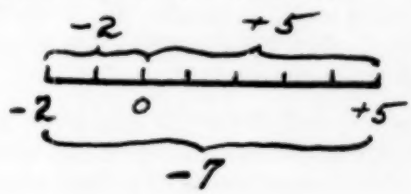


Fig. 4

(d) From −2 subtract +5.

Solution.—Beginning at +5, count 7 units to the left to −2. This shows that the difference is −7.

Hence $-2-(+5)=-7$
Since $-2+(-5)=-7$
It follows that $-2-(+5)=-2+(-5)$

From the above illustrations, it is seen that in every case a subtraction problem may be replaced by an addition problem which gives the same result if the subtraction rule is used. The rule is then given to the pupils.

II. Another device[4] used to make the process of subtraction habitual is given in the following tabular form:

The rule for subtraction of signed numbers is suggested by the following problems:	A. Signs as given; subtract	B. Signs changed; add
1. Subtract +2 from +6	+6	+6
This means: (+2)+?=6. Or +4	+2	−2
Hence, (+6)−(+2)= +4	+4	+4
2. Subtract −2 from +6	+6	+6
This means: (−2)+?=6. Or +8	−2	+2
Hence, (+6)−(−2)= +8	+8	+8
3. Subtract +2 from −6	−6	−6
This means: (+2)+?= −6. Or −8	+2	−2
Hence, (−6)−(+2)= −8	−8	−8
4. Subtract −2 from −6	−6	−6
This means: (−2)+?= −6. Or −4	−2	+2
Hence, (−6)−(−2)= −4	−4	−4

In column A on the right, the problem is arranged as usual for a subtraction problem, with the result as it is obtained in the solution on the left. In column B on the right, the sign of the subtrahend has been changed from + to −, or from − to +. The correct result is then obtained by adding. The pupils are then given the rule of subtraction.

III. In a recent article[5], its writer advocates the teaching of subtraction of signed numbers by means of the Austrian Method. The process can then be fixed and further rationalized by a simple illustration. Thus the subtraction problem

[4]Wells and Hart, "First Year Algebra," Boston, D. C. Heath & Co., 1912. Pp. 41-44.
[5]Christofferson, H. C. "The Teaching of Positive and Negative Numbers," SCHOOL SCIENCE AND MATHEMATICS, Vol. XXV, May, 1925.

$$\begin{array}{r} 50 \text{ cents} \\ 15 \text{ cents} \\ \hline \end{array}$$

can be thought of as asking "50 cents minus 15 cents equals what?" Or it can be thought of as asking, "What number must be added to 15 cents to make 50 cents?"

Similarly subtract as indicated below

$$\begin{array}{r} +10^\circ \\ -15^\circ \\ \hline \end{array}$$

by asking "What number of degrees must be added to -15° to make $+10^\circ$?" Clearly the answer is $+25^\circ$. The writer further suggests that a large number of problems involving all of the possible combinations be presented to the class, such as the following:

$+25^\circ$	$+25^\circ$	-25°	-25°	-25°	$+25^\circ$
-10°	$+10^\circ$	-10°	$+10^\circ$	-25°	-25°
$+35^\circ$	$+15^\circ$	-15°	-35°	0°	$+50^\circ$

He goes on to say that a convenient illustration to help the pupil to visualize and therefore more fully rationalize the subtraction process is actually to find the difference between two signed numbers. Thus, if the thermometer reads -10° at Superior when it reads $+15^\circ$ at St. Louis, what is the difference in temperature between the two cities? There would of course be two ways of thinking of this difference. The temperature at St. Louis may be thought of as being 25° higher than at Superior, or the temperature at Superior may be thought of as being 25° lower than at St. Louis. The sign of the difference then depends clearly on the way you count, and will always be the same as the direction of counting. Thus, in the problems below, the direction of counting in the first and third is up, therefore the difference is positive; and in the second, fourth and fifth the direction is downward, therefore the sign of the difference is minus.

$+10^\circ$	-10°	-10°	$+10^\circ$	-15°
-15°	$+15^\circ$	-15°	$+15^\circ$	-10°
$+25^\circ$	-25°	$+\ 5^\circ$	$-\ 5^\circ$	$-\ 5^\circ$

This method of determining the sign of the difference is somewhat artificial, and while the illustration helps to visualize the process, the teacher should go back to the Austrian method

used before to master the concept of subtraction. After the process has some meaning the subtraction law may be explained as follows and used:

In subtraction, the number from which another is subtracted is called the *minuend*, and the number subtracted is called the *subtrahend*; the result is called the *difference*. By checking any or all of the exercises in subtraction, you will notice that in each case the same difference would have been obtained by changing the sign of the subtrahend and then adding. The law of subtraction is then stated as a short cut process to eliminate the necessity of thinking through the actual process each time.

IV. Nyberg[6] presents an interesting method. He begins by explaining that subtraction in algebra does not mean finding what is left after something is taken away, but involves finding what must be added to the subtrahend to obtain the minuend. He finds that this can be done easiest by using equations, a subject which is usually begun fairly early in the course and should be available when subtraction is reached. Thus, let x = what must be added to -6 to obtain 10. Arrange several problems on the blackboard in such a scheme as:

Subtrahend	-6	$+5$	-7
Minuend	$+10$	-3	-2
	$-6+x=10$	$5+x=-3$	$-7+x=-2$
	$+6 \quad =+6$	$-5 \quad =-5$	$+7 \quad =+7$
	$x=16$	$x=-8$	$x=5$

The following questions are then asked: "What was added to each member of the equation? What was added to the minuend in each problem?" Nyberg maintains that this analysis is easier to understand than why the loss of a debt is the same as the gain of an asset, etc. The pupil sees that subtraction involves two steps, the multiplication by -1 followed by an addition.

V. Schultze[7] offers still another procedure as follows: In performing the subtraction $(-5)-(-3)$, he represents -5 by writing five negative units, -1, -1, -1, -1, -1, and requests the pupil to take away (with the eraser) -3, that is, three negative units. The result is obviously -2, or $(-5)-(-3)=-2$. Similarly, the total value of the following array of numbers is 2.

[6]Nyberg, Jos. A. "Plus and Minus Signs in Algebra," SCHOOL SCIENCE AND MATHEMATICS, Vol. 20, May, 1920, p. 436.
[7]Schultze, Arthur, "The Teaching of Mathematics in Secondary Schools," New York Macmillan Co., 1923, pp. 308-309.

+1	−1
+1	−1
+1	−1
+1	
+1	

Now if you choose to subtract −2, merely erase two negative units and the result is 4, or $2-(-2)=+4$.

VI. Probably the most effective method of presenting the subtraction of signed numbers is given by McCaughan[8], who believes in rationalizing the process as the opposite of addition. Before developing the process of subtraction, he acquaints the pupil with the number scale and makes sure that the pupil understands that adding a positive number to any other number makes it (the other number) larger or sends it up the number scale, or causes the mind to count up the number scale; and that the addition of a negative number to any other number makes it (the other number) smaller, or sends it down the number scale. He further advocates that these principles be written on the blackboard during the development of subtraction. The teaching (given as presented by McCaughan) now takes place as follows:

"Teacher: What process in arithmetic is the opposite of addition?
Pupils: Substraction. (Give time for every pupil to approve this answer.)
Teacher: If you are right (pointing to principle (b) on the board), what ought to be the effect of substracting a positive number from any other number? (Give pupils time to do their own thinking.)
Pupils: It ought to make it smaller, if substraction has the opposite effect of addition.
Teacher: [on board] Substract

5	5	5	5
4	3	2	1
—	—	—	—
1	2	3	4

What was the effect on the 5 each time that you substracted a (positive) number from it?
Pupils: Substracting a positive number from 5 made it smaller. This was always the effect in arithmetic.
Teacher: How did you prove the correctness of the remainder in arithmetic? [Be sure to take time enough here to get this from the pupils themselves. Commit every pupil to the correctness of the check.]
Pupils: If the remainder is added to the substrahend the sum is the minuend. [After the class agrees to this principle write it, for future reference, under principle (b). The teacher should use and require the pupils to use the correct words in talking about the parts of a substraction example.]
Teacher: Where do you begin to count in a substraction problem?

[8]McCaughan, J. Z. A. "Science and Mathematics," State Course of Study for Secondary Schools, Department of Public Instruction, State of Indiana, Bulletin No. 65 C, p. 188.

Pupils: At the minuend.

$$\begin{array}{r} 7 \\ 4 \\ \hline 3 \end{array}$$

Means that if you count four down from seven you come to three. [Teacher here takes time and illustrations enough to fix this point. It should then be written on the board with the other principles.]

Teacher: In the problem

$$\begin{array}{r} 7 \\ 4 \\ \hline 3 \end{array}$$

7, the minuend, is the number to have something done to it. Which number shows how much you are going to do to the 7?

Pupils: The 4 shows how much we are going to change the 7.

Teacher: Does the substrahend show this in every example of subtraction? [Illustrate as much as is necessary.]

Pupils: It does.

Teacher: What is the remainder when any number is taken from itself? [Illustrate until the pupils all agree to the correct answer.]

Pupils: Any number subtracted from itself leaves zero. [Write on board "If any number be subtracted from itself, the remainder is zero." Use a good variety of illustration here after the generalization has been made]:

$$\begin{array}{rrrrrrrrrr} 3 & 6 & -6 & -x & 3xy & x \text{ plus } y & & 236 & -18 \\ 3 & 6 & -6 & -x & 3xy & x \text{ plus } y & & 236 & -18 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}$$

$$\begin{array}{rr} x & 2a^2 \\ -x & 2a^2 \\ \hline ? & ? \end{array}$$

Now put on the board the following series, leaving vacant space at each end. Always let the pupils pronounce the remainder:

$$\begin{array}{rrrrrr} 5 & 5 & 5 & 5 & 5 & 5 \\ 5 & 4 & 3 & 2 & 1 & 0 \\ \hline 0 & 1 & 2 & 3 & 4 & 5 \end{array}$$

Call attention now to the change in the subtrahends and then to the resulting change in the remainder. Get the pupils to state that "as the subtrahend gets one smaller the remainder gets one larger." Have the pupils "check" each result. Now add to the right of the above series, asking the pupils to furnish you with next smaller subtrahend than 0. They furnish you with -1. Write

$$\begin{array}{r} 5 \\ -1 \\ \hline \end{array}$$

Do not let the bright children talk too soon here. After waiting until all the children have decided on the remainder, write where they may easily erase the example and under it the remainder reported. Those will probably be 4, -4, 6. Write

$$\begin{array}{rrr} 5 & 5 & 5 \\ -1 & -1 & -1 \\ \hline 4 & -4 & 6 \end{array}$$

Now require the class to check the result. Let the pupils decide which remainder checks. After finding that plus 6 is the correct result write it

up in the series you started with and let the class decide whether the 6 is consistent with the other remainders. Some pupils will balk at this. Give them a little time and hold them to the fact that they agreed to the check to determine the correctness of the remainder. Some pupils will say "but 1 from 5 leaves 4." Pupils should be told to keep in mind that they are now in a new situation which has no exact counterpart in arithmetic.

At this stage your series on the board is

5	5	5	5	5	5	5	5	5	5	5
5	4	3	2	1	0	−1	−2	−3	−4	−5
0	1	2	3	4	5	6	7	8	9	10

Now again call attention to the change in subtrahends moving from right toward the left, and have the children state the corresponding effects in the remainders. Then introduce at the left of the

5		5
5	the example	6
0		−1

Again hold the bright pupils in check while the slower ones are deciding. Require every pupil to check his result before any one is allowed to report a remainder. The big majority of the class should give a correct report for this example. Write it up in the series, check it and put up. Leave the series on the board as it now stands:

5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
9	8	7	6	5	4	3	2	1	0	−1	−2	−3	−4	−5
−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10

Now start a new series with

−5
−5
?

Revert to the principle "Every number from itself leaves zero," and secure the correct result. Check. Next take

−5		−5
−4	Check.	−3
−1		−2

When this series gets to this form:

−5	−5	−5	−5	−5	−5
−5	−4	−3	−2	−1	0
0	−1	−2	−3	−4	−5

stop again and ask the pupils to note the changes in substrahends and remainders. Keep up the checking. Then build on each side of the series above till it appears as follows:

−5	−5	−5	−5	−5	−5	−5	−5	−5	−5	−5	−5	
−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4, etc.
3	2	1	0	−1	−2	−3	−4	−5	−6	−7	−8	−9

Now you have this series beneath the one where the minuends are positive. Have the pupils note the results in which (as in arithmetic) the taking away of a positive number from any other number made that other number smaller, or sent it from the minuend down the number scale. Then observe the cases in which the subtrahend is a negative number and let the pupils state the effect of subtracting a negative number. Write these two principles with the others; subtracting a positive number from any other number makes it smaller; subtracting a negative number

from any other number makes it larger. Call attention now to the pupils' agreement that substraction is the opposite of addition.

Now comes the time for drill with small numbers, refering each example to the number scale to locate the starting point (the minuend) the direction to count (shown by the sign of the subtrahend) and the one of the two principles of subtraction and the distance to count on the number scale (shown by the number of units)—absolute value in the subtrahend. Check each remainder.

After pupils have the method learned they need practice by working such subtraction exercises as are furnished by any ordinary text. After this practice the more difficult cases of subtraction should be brought in, for example:

$$\begin{array}{cccc} a & a^2 & -2x & 5x-3y \\ 1 & a & -3 & 3x-b \\ \hline a-1 & a^2-a & -2x+3 & 2x-3y+b \end{array}$$

$$\begin{array}{cc} 2x+3y & -2x^2+5xy-3y^2 \\ 5x-3y+6 & -3x^2 \qquad -2y^2 \\ \hline -3x+6y-6 & x^2+5xy-y^2 \end{array}$$

In the first example a pupil should be led to reason. "Taking $+1$ from a will make the a smaller. To express that a is made smaller by 1, I would have to write '$a-1$.' In

$$\begin{array}{c} -2x \\ -3 \\ \hline -2x+3 \end{array}$$

taking away -3 from $-2x$ would make $-2x$ larger. The only way I can make $-2x$ larger by 3 is to write $-2x+3$," etc. The pupils should now be ready, with the teacher's guidance, to summarize their mental acts for each case of subtraction as:

1. Think the beginning place (minuend).
2. A direction to count (inferred from one of the two subtraction principles).
3. The amount to count in the direction determined.
4. The "landing" place, the remainder."

The writer is aware of the fact that there are other methods of developing the process of subtracting signed numbers, but he feels that he has compiled the procedures whose steps are unique and highly useful in explaining the process, thus helping to forestall subsequent learning difficulties that might arise because subtraction has not been mastered. He also wishes to point out that he does not advocate that the teacher use all of the methods presented, but rather that method which in the teacher's judgment will best overcome the difficulty that arises when teaching a particular class.

NEW FINISH FOR ALUMINUM.

A new, simple and cheap method of giving aluminum a dead white finish is described by Leon McCulloch, research chemist of the Westinghouse Electric and Manufacturing Co. The metal is boiled in milk of lime to which a little calcium sulphate is added. The new coating will be tested as a base upon which to apply paints and enamels to aluminum.—*Science News-Letter.*

THE HIGH SCHOOL CHEMISTRY LIBRARY.
(Some Desirable Offerings.)

By Miss Muriel C. Gere, *Lincoln (Neb.) Senior High School;*

J. J. Gunther, *Omaha (Neb.) Technical High School;*

B. Clifford Hendricks, *University of Nebraska.*

"I have been allowed one hundred dollars for use in obtaining some desirable chemistry books for our college library, can you give me some help in finding those books?" was the question presented to one of the authors in a recent letter. The following list[1] of titles, publishers, and approximate prices was used as an answer.

The last magazine list of such titles for chemistry which was at all general in scope is over four years old.[2] The last five years have witnessed an unusual output of desirable books for the high school chemistry library. So the list that follows may be helpful to a wider range of readers than just the chemistry teachers of one state.

While the authors had in mind the published suggestions[3] of desirable characteristics of books for the high school chemistry library they have not been privileged to rate each book or magazine listed by such a scale. However, all books and magazines suggested are known through personal inspection by at least one and in many cases by two or more of the authors.

They feel that the library is a close second to the laboratory in its order of importance to the high school chemistry course. The books should be of two sorts: (1) Those which boys and girls will want to take home to read as a pleasurable pastime and (2) books which are authoritative treatments of different phases of chemistry, to be used for reference. It is needless to say the latter should be well indexed.

The following list is suggested as desirable. No school will get all of them at once, but the library should grow from year to year toward this list or its equivalent as an ideal. First choices in the list are indicated by one star, second by two stars, etc.

Books of the Interest Type.

(Schools not having a chemistry library might start with at

[1]Published with the permission of the Nebraska State Department of Public Instruction.
[2]J. H. Walton, School Science and Mathematics, 25, 390-4 (1925).
[3]Jour. Chem. Educ. 5,861-867 (1928).

least the first five (price $2.50) of the following books. All of the first nine are sold by The Chemical Foundation, 654 Madison Ave., New York City.)

1. GENERAL.

Slosson—**Creative Chemistry.*
Vallery-Radot—***Life of Pasteur.*
Victor Defebure—*Riddle of the Rhine.*
Gregory—***Discovery or the Spirit and Service of Science.*
A Committee of American Scientists—*The Future Independence and Progress of American Medicine in the Age of Chemistry.*

(Price of the following, $1.00 each)

Howe—**Chemistry in Industry, Vol. I.*
Howe—**Chemistry in Industry, Vol. II.*
Hugh Farrell—***What Price Progress.*
Chamberlain—**Chemistry in Agriculture.*

(Price of the following, $2.00 to $3.50 each)

Hale—*American Chemistry* (1921)—Van Nostrand.
Slosson—**Chats on Science* (1924)—Century.
Cushman—*Chemistry and Civilization* (1925)—Dutton.
Arrhenius—***Chemistry in Modern Life* (1925)—Van Nostrand.
Findlay—*Chemistry in the Service of Man* (1925)—Longmans.
Howe—***Chemistry in the World's Work* (1926)—Van Nostrand.
Duncan—**Chemistry of Commerce* (1907)—Harper.
Sadtler—***Chemistry of Familiar Things* (1924)—Lippincott.
Bragg—***Concerning the Nature of Things* (1925)—Bell.
Hendrick—**Everyman's Chemistry* (1917)—Harper.
Ramsay—*Modern Chemistry* (1927)—Dutton.
Ramsay—*Manual on Explosives* (1917)—Dutton.
Martin—**Modern Chemistry and Its Wonders* (1923)—Samson.
Slosson—***Keeping Up with Science* (1924)—Harcourt.
Flinn—**Popular Research Narratives* (1924-1926)—Williams.
Foster—***Romance of Chemistry* (1927)—Century.
Phillps—*Romance of Modern Chemistry*—Lippincott.
Slosson—*Sermons of a Chemist* (1924)—Harcourt.
Martin—**Triumphs and Wonders of Modern Chemistry* (1923)—Samson.
Greer—***The Reign of Rubber* (1922)—Century.
Findlay—**Treasures of Coal Tar* (1918)—Van Nostrand.
Darrow—*Story of Chemistry* (1927)—Bobbs.

(Price, $5.00 to $5.25)

Armstrong—*Chemistry in the Twentieth Century* (1924)—Macmillan.
Tilden—***Chemical Discovery and Invention in the Twentieth Century* (1922)—Dutton.

(Price, 60 cents to $2.00 each)

Faraday—***Chemical History of a Candle* (1903)—Harper.
Brownlee et al—*Chemistry of Common Things* (1914)—Allyn.
Bull—*Chemistry of Today* (1922)—Lippincott.
Collins—*Wonders of Chemistry* (1922)—Crowell.

2. AGRICULTURE AND FORESTRY.

(Price, $3.00 to $3.50 each)

Hawley—*Forest Products in Chemical Industries*—U. S. Dept. of Agri.
Collins & Redington—***Plant Products and Chemical Fertilizers* (1926)—Bailliere.
Whitney—***Soil and Civilization* (1925)—Van Nostrand.

3. HOUSEHOLD CHEMISTRY.

(Price, $1.50 to $3.50 each)

Beery—***Chemistry Applied to Home and Community* (1926)—Lippincott.
Howe & Turner—*Chemistry and the Home* (1927)—Scribner.
Snell—***Elementary Household Chemistry* (1925)—Macmillan.
No. 55—*Measurements for the Household* (1915)—Bureau of Standards.
No. 70—*Materials for the Household* (1917)—Bureau of Standards.
No. 75—*Safety for the Household* (1918)—Bureau of Standards.

4. Health and Medicine.

(Price, $2.00 to $4.00 each)

Sherman—**Chemistry of Food and Nutrition* (ed. 3) (1926)—Macmillan.
Wiley—*Foods and Their Adulteration* (1917)—Blakiston.
Mendel—**Nutrition, the Chemistry of Life* (1923)—Yale Univ. Press.

(Price, $1.50 to $2.40 each)

Rose—**Feeding the Family* (1924)—Macmillan.
Stieglitz—**Chemistry and Recent Progress in Medicine* (1924)—Williams.
—**Chemistry in Medicine* (1928)—Chemical Foundation.

5. Industry.

(Price, $1.50 to $2.50 each)

Boyd—***Gasoline: What Everyone Should Know about It* (1925)—Stokes.
Hale & West—***Survey of American Chemistry* Vol. 1 (1926); Vol. II (1927)—Chem. Catalogue.
Bardorf—***The Story of Sugar* (1924)—Chem. Pub. Co.
Pilcher & Jones—*What Industry Owes to Chemical Science* (1924)— Van Nostrand.

(Price, $3.00 to $4.00 each)

Farnham et al—***Profitable Science in Industry* (1925)—Macmillan.
Davis—***The Story of Copper* (1924)—Century.
Fuller—***The Story of Drugs* (1922)—Century.
Walker—*The Story of Steel* (1926)—Harper.

(Price $7.50)

Hadfield—***Metallurgy and Its Influence on Modern Progress* (1925)—Van Nostrand.

(Price, $4.50 and $16.50 each respectively)

Martin—**Industrial and Manufacturing Chemistry* (Inorganic) (1922)—Lockwood.
Rogers—**Elements of Industrial Chemistry* (Condensed) (1926)—Van Nostrand

6. History and Biography

(1) Biography (Price, $3.50 to $4.00 each)

Thorpe—***Essays in Historical Chemistry* (1911)—Macmillan.
Tilden—***Famous Chemists, The Men and Their Work* (1921)—Routledge.
Pioneers of Progress: Men of Science (Price 80 cents and $1.00)—Macmillan.
Crowther—***Life and Discoveries of Michael Faraday* (1918).
Neville-Polley—***John Dalton* (1921).
Peacock—***Joseph Priestley* (1919).

(2) Histories (Price, $1.60 to $2.50)

Thorpe—*History of Chemistry* (1910)—Putnam.
Moore—**A History of Chemistry* (1918)—McGraw.
Venable—***A Short History of Chemistry* (1922)—Heath.

(Price, $3.00 to $4.00)

Harrow—**Eminent Chemists of Our Time* (1927)—Van Nostrand.
Smith—*Chemistry in America* (1914)—Appleton.

7. Miscellaneous.

(Price, $1.75 to $6.50)

Bancroft—**_Applied Colloidal Chemistry_ (1926)—McGraw.
Ramsay—*_Gases of the Atmosphere: Their History and Discovery_ (1916)—Macmillan.
Vedder—**_Medical Aspects of Chemical Warfare_ (1925)—Williams.
Thompson—**_The Electron in Chemistry_ (1923)—Franklin Institute.

BOOKS OF THE REFERENCE TYPE

(All high schools should ultimately have some of these.)

1. COLLEGE TEXT BOOKS

(1) General (Price, $3.00 to $4.00)

Bartlett & Ink—_Principles of Chemistry and Their Application_ (1927)—Macmillan.
Cady—**_General Chemistry_ (1926)—McGraw.
Chapin—*_Second Year College Chemistry_ (1925)—Wiley.
Deming—*_General Chemistry_ (1925)—Wiley.
Foster—**_Introduction to General Chemistry_ (1924)—Princeton Uni. Press.
Gordon—**_Introductory College Chemistry_ (1926)—World.
Latimer and Hildebrand—*_Reference Book of Inorganic Chemistry_ (1928)—Macmillan.
Hildebrand—_Principles of Chemistry_ (1926)—Macmillan.
Holmes—*_General Chemistry_ (1921)—Macmillan.
Lincoln & Banks—_General Chemistry_ (1928)—Prentice.
McPherson & Henderson—*_A Course in General Chemistry_ (1927)—Ginn.
Mellor—*_Modern Inorganic Chemistry_ (1925)—Longmans.
Newell—*_College Chemistry_ (1925)—Heath.
Smith & Kendall—*_College Chemistry_ (1923)—Century.

(2) Problems and Questions (Price, 80 cents to $1.20)

Darrow—_Questions in Chemistry_ (1921)—Harcourt.
Pugh & Miller—_A Problem Course in Chemistry_ (1921)—Allyn.

(3) Analytical (Price, $4.50 and $7.50)

Griffin—**_Technical Methods of Analysis_ (1927)—McGraw.
Treadwall & Hall—**_Analytical Chemistry Qualitative_ (1924)—Wiley.

4. Organic (Price, $2.50 and $4.00)

Bernstein & Sudburough—_Textbook of Organic Chemistry_—Van Nostrand
Chamberlain—_Textbook of Organic Chemistry_ (Revised) (1928)—Blakiston
Cohen—_Theoretical Organic Chemistry_ (1920)—Macmillan.
Norris—**_Principles of Organic Chemistry_ (1922)—McGraw.

(5) Physical (Price around $3.00)

Bigelow—_Theoretical and Physical Chemistry_ (1927)—Century.
Crocker & Matthews—*_Theoretical and Experimental Physical Chemistry_ (1928)—Macmillan.
Senter—_Outlines of Physical Chemistry_ (1926)—Van Nostrand.
VantHoff—_Physical Chemistry in the Service of the Sciences_ (1903)—Chicago Univ. Press.

6. Physiological (Price $6.50)

Hawk & Bergeim—_Practical Physiological Chemistry_ (1926)—Blakiston.

2. TREATISES ON CHEMISTRY

Roscoe & Schorlemmer—_Treatises on Chemistry_, Vol. I (Non-metals) $9.00 (1920); Vol. II (Metals), $15.00 (1923)—Macmillan.
Molinari—**_Treatise on General and Industrial Chemistry_ (1920) ($12.00)—Blakiston.

3. DICTIONARIES

Turner et al—_The Condensed Chemical Dictionary_ (1919) ($7.00)—Chem. Cat.

(Information about commercial substances)
Thorpe—*Dictionary of Applied Chemistry* (1926) ($20.00)—Longmans.

4. MAGAZINES

Pauline Beery—*Chemistry Leaflet*—State College, Pa.
Neil Gordon—*Journal of Chemical Education*—Baltimore, Md.
Watson Davis—*Science News Letter*—21st—B Sts. N. W., Washington, D. C.

BOOKS AND MAGAZINES FOR THE TEACHER

**Bulletin* No. 26 (1920)—Bureau of Education, Dept. of Interior, Washington.
***Industrial and Engineering Chemistry* (Magazine)—1709 G St. N. W., Washington.
**School Science and Mathematics* (Magazine)—1439 14th St., Milwaukee.
Smith & Hall—***Teaching of Chemistry and Physics* (1919)—Longmans.
Twiss—**Science Teaching* (1917)—Macmillan.
**Chemical Education* (Magazine)—The Johns Hopkins University, Baltimore, Md.
***Science Education* (Magazine)—Salem, Mass.
Brownell & Wade—*The Teaching of Science and the Science Teacher* (1925)—Century.
Frank—**Teaching First Year Chemistry* (1927)—The Author, Oshkosh, Wis.
Benedict—*Chemical Lecture Experiments* (1901)—Macmillan.
Newth—*Chemical Lecture Experiments* (1923)—Longmans.
Cook—*New Type Questions in Chemistry* (1927)—Globe.
Curtis—*Investigations in the Teaching of Science* (1926)—Blakistons.

OTHER NOTABLE CHEMISTRY LIBRARY LISTS.

Earl R. Glenn—*School Science and Mathematics*, 21, 477-482 (1921).
W. A. Hamor—*The Journal of Industrial and Engineering Chemistry*, 12, 701-705; 806-812 (1920).
Crane and Patterson—*The Literature of Chemistry*, 346-423 (1927)—Wiley.

INSECTS FOR SCHOOL STUDY TOPIC OF NEW BULLETIN.

Because of the menace of insects to crops, agricultural schools of all grade groups endeavor to teach some of the fundamental facts of the insect world. To aid teachers in their teaching, particularly those who have not had special training in certain agricultural subjects, the U. S. Department of Agriculture has issued an illustrated bulletin, Farmers' Bulletin 1601-F, "Collection and Preservation of Insects for Use in the Study of Agriculture," by Margaret C. Mansuy of the Bureau of Entomology. The department believes the bulletin will be of value to amateur collectors of insects also.

The bulletin suggests what materials should be collected and tells where to find them, tells what equipment to use on collecting trips, tells how to kill, pin, spread, and mount specimens, how to fumigate to prevent destruction of specimens by museum pests, gives directions for preserving immature stages of insects and for mounting minute insects, makes suggestions for rearing live insects in breeding cages, and tells how to ship specimens for identification or exchange with other collectors.

As long as the supply lasts, the bulletin may be obtained free from the Office of Information, Department of Agriculture, Washington, D. C. upon request.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University,

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTIONS OF PROBLEMS.

1073. *Proposed by R. T. McGregor, Elk Grove, Calif.*

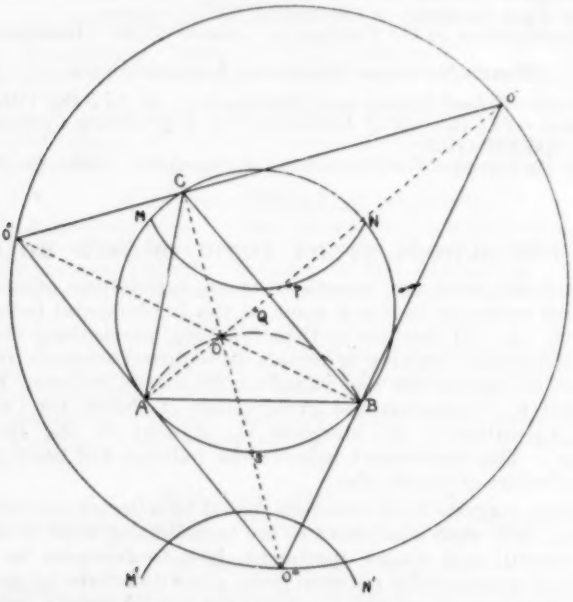
Given the base and the vertical angle of a triangle, find the locus of the center of the circle which passes through centers of the three escribed circles.

Solved by Louis R. Chase, Newport, R. I.

Let ABC be the given triangle on one side of AB, Q the circumcenter, O the in-center, O′, O″, O‴ the ex-centers, P the circum-center of triangle O′O″O‴.

To find the locus of P.

O is the orthocenter of triangle O′O″O‴. (The in-center of a triangle is the orthocenter of the triangle having the ex-centers as vertices.)



Therefore circle ABC is the nine-point circle of triangle O′O″O‴.

Since angle AOB is constant, the locus of O is an arc of a circle upon AB as chord. (The center of this circle is S.)

The locus of P is an arc symmetrical with an AOB with respect to Q. (The center of the nine-point circle of a triangle bisects the join of the circumcenter and the orthocenter.)

Since C may lie on either side of line AB, the complete locus of P includes a reflection in line AB.

In the figure, arcs MPN and M'N' constitute the locus.

Also solved by *George Sergent, Tampico, Mexico;* and by the *Proposer.*

1074. *Proposed by the Editor.*

Find the value of i^i, where i is the square root of -1.

Solved by Robert Sinnott, Dorchester, Mass.

If A and B are any two complex numbers (A not equal to 0), we can define

$$A^B = e^{B \log A}$$

where logA has any one of its possible values. Thus

$$i^i = \sqrt{-1}^{\sqrt{-1}} = e^{i \log i}.$$

$$z = x + iy = r(\cos\theta + i\sin\theta)$$
$$= \sqrt{x^2+y^2}\, e^{i\theta}$$
$$\log z = 1/2 \log(x^2+y^2) + i \tan^{-1}(y/x).$$

For $z = i$, $\tan\theta = \text{pi}/2$; hence

$$\log i = i\ \text{pi}/2 + 2k\ \text{pi}\ i.$$
$$i^i = e^{-(\text{pi}/2 + 2k\ \text{pi})} = e^{-\text{pi}/2} \text{ times } (e^{2\ \text{pi}})^k.$$

The maximum value of i^i is given for $k = 0$; hence

$$i^i = e^{-\text{pi}/2} = .20788+$$

Editor's Note. This problem has an interesting history and many applications. Readers interested further should consult the American Mathematical Monthly, May, 1917, page 236, March, 1921, pages 114-121, where a detailed discussion can be found, as well as a good bibliography on the subject.

Also solved by *Robert J. Myers, Creighton University, Omaha, Neb.; Raymond Huck, Johnson City, Ill.; Glenn F. Hewitt, Madison, Indiana; Sudler Bamberger, Harrisburg, Pa.; H. D. Grossman, Brooklyn, N. Y.; Harold Skramstad, Tacoma, Wash.; A. L. McCarty, San Francisco, Calif.; J. Murray Barbour, Aurora, N. Y.;* and *Louis R. Chase, Newport, R. I.*

1075. *Proposed by Norman Anning, University of Michigan.*

Suggested by 1059. The hyperbola $X^2 - 2Y^2 = -1$ passes through the point (p, q) where p and q are positive integers. Prove that the curve passes through the point $(3p+4q, 2p+3q)$, and that between these two points it does not pass through any point both of whose coordinates are integers.

I. *Solved by A. L. McCarty, Lowell High School, San Francisco, Calif.*

From the theory of the Pell Equation (See E. E. Whitford, "The Pell Equation," page 75), since (1, 1) is the first solution,

$$p = \frac{(1+\sqrt{2})^{2n+1} + (1-\sqrt{2})^{2n+1}}{2}, \quad q = \frac{(1+\sqrt{2})^{2n+1} - (1-\sqrt{2})^{2n+1}}{2}.$$

If the next solution of the given equation is (p_1, q_1) then

$$p_1 = \frac{(1+\sqrt{2})^{2n+3} + (1-\sqrt{2})^{2n+3}}{2},$$

$$q_1 = \frac{(1+\sqrt{2})^{2n+1}(3+2\sqrt{2}) - (1-\sqrt{2})^{2n+1}(3-2\sqrt{2})}{2\sqrt{2}}.$$

Simplifying, we get

$$p_1 = 3p+4q \text{ and } q_1 = 2p+3q.$$

II. *Solved by J. Murray Barbour, Aurora, N. Y.*

Let $(p+a)$ and $(q+b)$ be the next pair of integral values after p and q. Substituting in the original equation and reducing gives $a(2p+a) = 2b(2q+b)$. $a = k(2q+b)$ and $2b = k(2p+a)$. Eliminating a gives $b = \frac{2k(p+kq)}{2-k^2}$. k may vary from 0 to 2, and its least value when b is integral is 1. Thus $b = 2(p+q)$ and $a = 2(p+2q)$. Hence, the next point

is $(3p+4q)$, $(2p+3q)$.

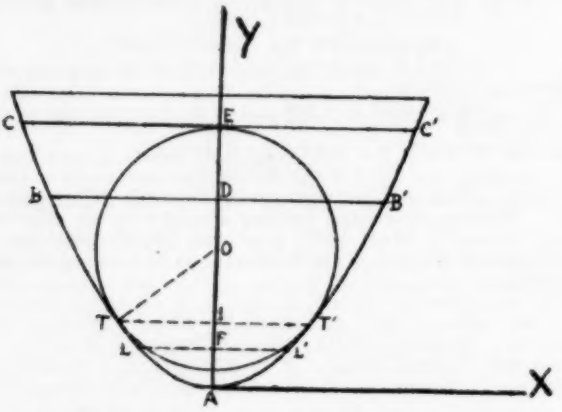
Also solved by the *Proposer*.

1076. *Proposed by S. M. Turrill, Maywood, Ill.*

The parabolic bowl $X^2=4Y$ is filled with water to a depth of 5 inches. Find the diameter of a sphere that will be placed in the bowl that will cause the water to just cover the sphere.

Solved by Sudler Bamberger, Harrisburg, Pa.

Choose the origin of coordinates at the vertex of the parabolic bowl. Then the equation of the cross section of the paraboloid is $4y=x^2$. The equation of the cross section of the sphere is $x^2+(y-c)^2=R^2$, (O, c) being the center of the circle. AD = 5 in. The volume of the segment of the



paraboloid ABB′ is 50 pi cu. in. (found by Integral Calculus). The volume of paraboloid

$$ACC'=1/2 \text{ pi } (EC')^2\times EA=50 \text{ pi}+4/3 \text{ pi } R^3=2 \text{ pi } (EA)^2.$$

Solving simultaneously the equations of the circle and the parabola, and setting the discriminant equal to zero (the condition for the tangency of the two curves), we get $c=(R^2+4)/4$. But $c+R=AE$; hence $AE=(R+2)^2/4$. Then volume of ACC′ is

$$50 \text{ pi}+4/3 \text{ pi } R^3=\text{pi}(R+2)^4/8.$$

Simplying, and solving the biquadratic equation by Horner's method, we get R = 3.276 in.

Also solved by *George Sergent, Tampico, Mexico; Smith D. Turner, Goose Creek, Texas; Raymond Huck, Johnson City, Ill.; Louis R. Chase, Newport, R. I.; Bessie Green-Andrews, Wichita, Kans.; E. A. Hollister, Pontiac, Mich.; J. Murray Barbour, Aurora, N. Y.;* and by the *Proposer*.

1077. *Proposed by H. D. Grossman, Brooklyn, N. Y.*

Prove that the triangle of minimum perimeter that can be inscribed in a given acute angled triangle is the triangle formed by joining the feet of the altitudes.

Solved by George Sergent, Tampico, Mexico.

Let ABC be the given triangle; D, E and F the feet of the altitudes; and H the intersections of the altitudes.

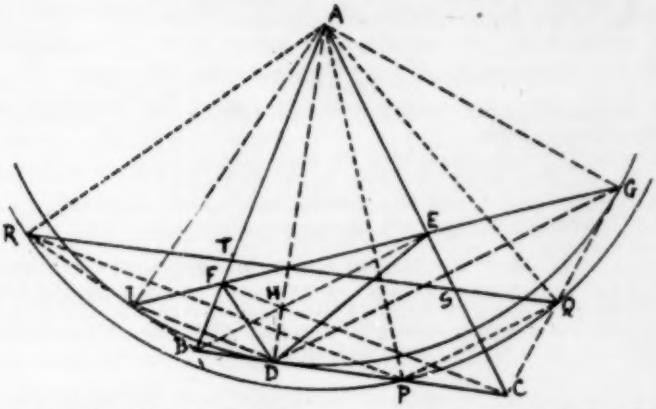
The quadrilaterals AEHF, BDHF, CDHE are cyclic. Hence

$$\angle AFE = \angle AHE = 90^\circ - \angle CAD = \angle C.$$
$$\angle BFD = \angle BHD = \angle AHE = \angle C;$$
$$\angle AEF = \angle BFD = \angle C.$$

Similarly,
$$\angle AEF = \angle CED = \angle B,$$
$$\angle BDF = \angle CDE = \angle A.$$

From any vertex, D for instance, of triangle DEF, draw ⊥s to the sides AC, AB of triangle ABC. Let G and I be, respectively, the intersections of these ⊥s with EF produced on both sides. We have

$$\angle CEG = \angle AEF = \angle B = \angle CED,$$
$$\angle BFI = \angle AFE = \angle C = \angle BFD.$$



The triangles DEG and DFI are isosceles, and DE = EG, DF = FI. Hence the straight line GI is equal to the perimeter of triangle DEF.

To prove the proposition, it is only necessary to prove that GI is shorter than the perimeter of the triangle of minimum perimeter that can be inscribed in triangle ABC when any other point P, on BC for instance, is taken as a vertex. To determine the perimeter of this triangle is to determine the shortest path from P to AC, thence to AB and back to P. The known construction is to find the symmetric, Q, of P with respect to AC; the symmetric, R, of P with respect to AB; and to draw QR, intersecting AC in S and AB in T. The triangles PSQ and PTR being isosceles, QR is equal to the perimeter of the triangle PQR.

We have by symmetry: AD = AG = AI; AP = AQ = AR, and $\angle GAI = \angle QAR = 2\angle A$. The isosceles triangles GAI and QAR are similar, and since AD is less than AP, it follows that AG is less than AQ, and GI is less than QR. This proves the proposition.

1078. *Proposed by E. de la Garza, Brownsville, Texas.*

Find three numbers of which their sum is 36, and such that the product of the first by the square of the second and the cube of the third is a maximum.

Solved by R. T. McGregor, Elk Grove, Calif.

Denote the second number by X, the third number by Y, and the first by $36 - X - Y$. Find the maximum value of

$$(36 - X - Y)X^2Y^3.$$

Set the partial derivatives, of this expression with respect to X and Y, equal to zero, which conditions are necessary for a maximum or a minimum. We get $3X + 2Y = 72$ and $3X + 4Y = 108$. Solving these equations gives $X = 12$, $Y = 18$. The first number is 6.

Also solved by *Bessie Green-Andrews, Wichita, Kans.; George Sergent, Tampico, Mexico; Lewis R. Chase, Newport, R. I.; Smith D. Turner, Goose Creek, Texas; H. D. Grossman, Brooklyn, N. Y.; J. Murray Barbour, Aurora, N. Y.*, and the *Proposer*. One incorrect solution was received.

PROBLEMS FOR SOLUTION.

1091. *Proposed by the Editor.*

Note. Professor Aubrey Kempner's Problem as suggested in the Mathematics Teacher for March, 1929.

Given two non-intersecting circles, C_1 and C_2, having centers at O_1 and O_2, the center of each of which does not lie in the other circle. From the center of each circle draw tangents to the other circle. Tangents from O_1 to circle C_2 determine on C_1 the chord A_1B_1. Tangents from O_2 to C_1 determine on C_2 the chord A_2B_2. Prove that $A_1B_1 = A_2B_2$.

1092. *Proposed by Norman Anning, University of Michigan.*

Find the exact value of the following expression for $t^3 = 2$:

$$\frac{(4t-5)^3}{(1-t)^8}.$$

1093. *Proposed by G. W. Wishard, Norwood, Ohio.*

$7^4+7^3+7^2+7 = 2800$.

Find other numbers which have the same property.

1094. *Proposed by P. H. Nygaard, Spokane, Wash.*

In a certain state A and B are candidates for the same office. It is expected that 450,000 votes will be cast for this office. The pre-election odds are even on the chances of A and B to win. The odds are also even that neither candidate will receive over 20,000 majority. (1). What is the probability of a tie vote? (2). What is the probability that the returns will be such that a switch of 1,000 votes from A to B would be enough to change the result from defeat to victory for B? (3). What should be the odds on A to win by at least 50,000 majority?

1095. *Miscellaneous.*

The product of the distances of the midpoints of the minor arcs subtended by the sides of an inscribed triangle from those sides, is equal to one-half the product of the radius of the circumcircle and the square of the radius of the incircle. Prove.

Obtain the relation corresponding to taking the midpoints of the major arcs.

1096. *Proposed by A. J. Spracklin, Sidney, Nova Scotia.*

If a person were to borrow $1,500 and pay $20 per month for 49 months, and then pays $15 per month for 62 months, how much does he still owe (interest 7 per cent annually)?

WOOD ACIDS CORRODE LEAD.

The creosoted wood conduits in which lead-coated telephone cables are sometimes cased for protection may, under some circumstances, become a menace instead of a means of preservation, according to R. M. Burns and B. L. Clarke of the Bell Telephone Company. In a communication presented before the American Chemical Society, they told of discovering in the air contained in such conduits appreciable quantities of volatile acids capable of corroding the lead sheathing. They have devised a method of estimating the quantity of such acids present, and told of their findings on a number of different kinds of lumber.—*Science News-Letter.*

RUSTPROOF STEEL WELDS.

Rustproof steel is easily welded by the acetylene-oxygen process and is even more rustproof after welding than before due to loss of carbon, silicon and manganese during melting. These findings by W. Hoffmann, German metallurgist, have just been announced by the National Advisory Committee for Aeronautics. The physical characteristics of rustproof-steel welds are better than those of soft-steel welds, but the hardness of the metal due to welding must be removed by heat treatment. The rustproof steels most used contain large percentages of chromium or chromium and nickel.—*Science News-Letter.*

WHOLESOME PUBLICITY WHILE YOU WAIT.

By Ralph E. Dunbar,

Dakota Wesleyan University, Mitchell, So. Dak.

The idea of industrial inspection tours is not new in science instruction. In most cases such trips are limited to local factories, where the number and type of industries visited can be so regulated as to augment the daily class work under consideration. However, where the variety of local possibilities is limited, a more extensive and intensive study may be made of suitable plants in some more distant city.[1] It was in connection with this latter type of tour that the following plan of procedure and publicity was devised. We believe the plan has sufficient merit to warrant its adoption by other similar groups where conditions will permit. This particular trip was the third annual tour of the department of chemistry. The itinerary included as usual, a biscuit factory, packing plant, clinic, engraving company, foundry, candy factory, paint factory, bottling works, rope and twine factory, water aeration and filtration plant, and newspaper shop.

A group of thirty-seven students under the direct supervision of an instructor in the department left the campus at six o'clock in the morning arriving in the city to be visited by eight o'clock. Two large highway buses had previously been engaged for transportation. By previous arrangement the group was met by a photographer at a designated hour and place. A photograph was taken of the entire group together with the buses. The students were already sufficiently familiar with the photographic operations involved to omit this feature of the operation. Within one hour, however, the studio had a wet print ready for the engraver. This one picture was furnished to the engraver free of charge for a sufficient number of additional copies were ordered by the members of the group to compensate the photographer well for his work. In addition all parties co-operating in this project were given due credit in the publicity that followed.

The engraver, also by previous arrangement, had kindly consented to prepare a three column zinc half-tone from this photograph, taken an hour earlier. All students involved were present and witnessed the entire process. The necessary explanation covering all details was given by the engraver as he

[1]Dunbar, School Science and Mathematics, Vol. XXVIII, No. 8, Nov. 1928, p. 855.

worked. Needless to say every one present took much greater interest in the preparation of this particular cut than any other prepared on similar occasions.

The city editor of the Sioux Falls Argus-Leader had been supplied with all necessary details two days before and had been notified of the hour when the cut should arrive. Here again the students observed all the essential steps in the preparation of a typical daily newspaper, and were more attentive and interested because of the fact that their own picture was involved. Thus by a carefully prearranged schedule and coordination with the three plants involved, the photographer, engraver, and newspaper, the group picture was reproduced in three hours after the arrival of the group in the city. Needless to say the plan added much to the general success of the day, and was in reality, "wholesome publicity while you wait," both for the school and the classes involved.

Every student eagerly purchased copies of the Sioux Falls Argus Leader that day from newsboys on the streets carrying a three column picture and the following account of the day's visit:

"Thirty-seven science students of Dakota Wesleyan University of Mitchell, arrived in the city this morning at 8:00 o'clock on their third annual science industrial tour. They are under the direct supervision of Prof. Ralph E. Dunbar, head of the chemistry department. The group has chartered two large highway buses and have used the same to convey them from plant to plant today while in the city.

"The group left Mitchell this morning at 6:00 o'clock, arriving in Sioux Falls by 8:00 o'clock. The day has been an unusually busy one and the itinerary has included the plants of the Manchester Biscuit Co., John Morrell & Co., Sioux Falls Clinic, South Dakota Engraving Co., The Queen City Foundry Co., Fenn Brothers, Minnehaha Springs, South Dakota State Penitentiary, Sioux Falls waterworks and the Sioux Falls Argus Leader. Most of the students are attending the show at the State tonight. This is the third consecutive year that a group has made a similar tour of several of the leading manufacturing plants of the city, especially those that are of unusual interest to students of chemistry.

"As a new feature of this year's program, the picture produced herewith has been made possible only through the cooperation of three Sioux Falls business concerns. This picture was taken on the high school grounds this morning by the Green Dragon studio. The cut for its production was made by the South Dakota Engraving company, while the students were present to observe the entire process, and while this issue of the Argus Leader is being produced, this same group is present to watch the big presses in operation. All students pronounce the day's activities most interesting and worth while."

STIMULATING INTEREST IN MATHEMATICS.

By Elmer C. Warren,
Colby College, Waterville, Me.

During these years of curriculum adjustment, improvement of education, and transition in general, we who teach mathematics are being afforded opportunities for cooperation in the promoting and accomplishing of progressive measures for our subject.

How familiar we all are with drawing-room estimations of mathematics: indictments to the right, jeers to the left, uncertainty ahead, and a few cheers to the rear.

It is no secret that many dislike any study of a mathematical nature. Were we to inquire why our subjects are distasteful we would be told that mathematics is difficult, and that no one ever uses it outside the classroom. Teachers of mathematics are well aware that the subject matter of required courses is not so difficult as to breed dislike. Furthermore, any live teacher knows that the applications, practical and esthetic, are many and frequent.

The traditional problem solving courses in preparatory mathematics are certainly anything but conducive to fostering interest. The widespread antipathy with which we have to contend has been passed on from one to another, and is as responsible for the prevailing dislike as is the subject matter itself. Mathematics possesses a "beauty cold and austere," and the cold and austere have been allowed to prevail at the expense of the beauty.

The student of college age and calibre is quite naturally thinking about values. He questions the value of his studying mathematics, and quite properly, too. Students either like or strenuously dislike mathematics. With the former we are not interested at present. The latter, with his inbred distaste, is not easily convinced that mathematics has cultural as well as practical properties. His previous mathematical experience has been unpleasant, and he is unwilling to have mathematics commended to him for study.

The tendency has been to discontinue the mathematics requirements in college, except for science students. The elimination of requirements has been enhanced by the influence of alleged arguments relative to the disciplinary and the utilitarian values of the subject to the average student. Should and must the value of culture be measured in economic terms? Surely, there is something of finer and higher value in an education than mere dollars and cents. Even the staunchest opponent

of required mathematics has to admit that it has played a most significant part in the advance of civilization. The science student naturally studies mathematics; we are concerned more particularly with the arts student, who generally dislikes it. The arts student is essentially a student of culture, and for this, if for no other, reason he should be provided with courses describing the place of mathematics in the world of culture. Again, as Stern has so ably said, "Mathematical activity produces plastic emissions reaching far beyond the particular mathematical thinking." It would seem that such activity might be of inherent value to these culture-seeking students.

The question of the past has been: Should we require mathematics of everyone? Today we should assert the following: We as true teachers are required by the high ideals of our profession to provide appropriate mathematics courses for our various types of students.

I offer no panacea for solving the question of required mathematics, but I believe mathematics has a place in the life of everyone, whether his calling be engineering, science, business, or fine arts. It seems to me that herein lies a great opportunity for a profitable cooperation between the secondary school and college mathematics departments.

Students with the minimum fundamental concepts well in their minds can master details and new topics with comparative ease and interest. In preparatory work, then, if more stress were laid on the fundamental operations and their generalizations, less time spent on a number of separate topics, and considerable emphasis laid on biography, current literature, and problems from actual life, it seems probable that a live interest and a desire to know more might be bred in students. Moreover, the colleges could accomplish far more for students able to apply fundamentals and draw generalizations, than they do now. Students coming to college today have, in their preparatory courses, applied mathematics to many types of problems, but have two serious defects, namely; they do not know the real fundamentals of the subject, and cannot make applications except to problems they have previously encountered. Applications as ordinarily used to amplify courses do not constitute "generalization" as understood by mathematicians. The aim of mathematics is the generalization of laws, and especially, relations. Whitehead says, "The essence of mathematics is perpetually to be discarding more special methods in favor of general

methods." I repeat, if the time spent on rudiments could be increased, and some of the time used for the skimming applications might be devoted toward developing the esthetic, a better student with a better education would be the product. The real accomplishments, as I see them, would be that the college-going student would seek more mathematics courses, the student who does not attend college would have a clearer conception of the meaning and mission of mathematics, and most important, mathematics would be elevated to a plane of high esteem by everyone.

This paper is not offered as a solution. My one hope is that it will be suggestive, and act, in its small way, toward stimulating constructive thinking about the educational problems of mathematics.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,
The University of Oklahoma, Norman, Okla.

Fate laughs at probabilities.—*Edward Bulwer-Lytton, English novelist.*

The whole system of civilized life may be fitly symbolized by a foot rule, a set of weights, and a clock.—*James Clerk Maxwell, English physicist, in "Theory of Heat."*

In these days, the man who says that a thing cannot be done is quite apt to be interrupted by some idiot doing it.—*Elbert Hubbard, American author, lecturer, and editor.*

Mathematics is the method of replacing in the most comprehensive an *economical* manner possible, new numerical operations by old ones done already with known results.—*Ernst Mach in "The Science of Mechanics," a classic of the first importance to students of the history, philosophy, and theory of physical science.*

That scientific discovery *may* put not only dollars into the pockets of individuals, but millions into the exchequers of nations, the history of science amply proves; but the hope of its doing so never was and never can be the motive power of the investigator.—*John Tyndall, British physicist, in "Lectures on Light."*

. . . that old medium, the ether—invented by man for the purpose of propagating his misconceptions from one place to another—the ether which of all the subtle fluids invented for the stimulation of the imagination, is the only one which has so far not been prohibited.—*W. F. G. Swann, physicist, "Journal of the Franklin Institute," April, 1921.*

On the whole the object of reflection is invariably the discovery of something satisfying to the mind which was not there at the beginning of the search. There is no fundamental difference between this discovery and scientific invention. "How did you discover the law of gravitation?" somebody once asked Newton. "By thinking about it all the time," was the answer. —*Ernest Dimnet in "The Art of Thinking."*

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

1. *What is interesting to your students?*
2. *What do you like to teach them?*
3. *Do they like it?*
4. *Are teaching and selling alike? If not, why?*
5. *Do pupils like subjects that make them think?*

The above runs through the Editor's mind as his faithful typewriter automatically prepares the copy for November.

EDISON'S GOLDEN LIGHT JUBILEE QUESTIONS.

"Who shall be my successor? Boys, answer the following questions and find out." In this wise might Thomas A. have announced his competition.

The daily press gave the entire subject a great deal of publicity last August when the examinations were taken.

Science Question No. 541. (Try them on your classes *before* they have studied Physics or Chemistry and again near the close of the year *after* they have studied the subjects for a few months. It will give you more information than you can get from the Iowa Physics Tests, Thurstone's Tests, the World Tests, Jones' Union Science Tests, and the Columbia Tests combined. See if it doesn't).

Questions Edison Puts to Boys After His Job.

PHYSICS, CHEMISTRY AND MATHEMATICS.

1. Define work, energy and power and give an illustration of each. How does weight differ from mass? How does force differ from energy? Would a body weigh more or less on the moon than on the earth? Why? Where would bodies weigh nothing?

2. The specific heat of water is 1 and of mercury 0.033; the specific gravity of water is 1 and of mercury 13.6. For a foot warmer, state which you would choose and why: A two-quart hot-water bottle filled with water at 100 degrees C or two-quart flask of mercury at 100 degrees C?

3. Specific resistance of an alloy is four times as great as that of copper. A copper wire 1,000 feet long has the resistance of 40 ohms. How long a wire of the alloy having the same diameter as the copper wire would have the same resistance as the copper wire?

4. The index of refraction of a glass is 1.5 and of another glass 1.7. If a biconvex lens of the same geometrical design was made of each of the two glasses, how would they differ optically? If they were placed in a transparent liquid of index of refraction 1.6 what effect would each have on a beam of light parallel to its principal axis?

5. The captain of a boat when passing a certain cliff on a summer night heard the echo of his whistle four seconds after blowing. How far away was the cliff? If he repeated this observation from the same point on a day in January, would he notice any change in the time? If so, what and why?

6. The volume of an automobile tire is approximately 900 cubic inches and it is pumped up to a gauge pressure of 60 pounds per square inch. Its temperature is 20 degrees C. Left in the sun its temperature increased 35 degrees C. and it exploded. What was the volume of the expanded air directly after the explosion? Could the pressure just prior to the explosion be computed from the above data?

7. When you read the names of the following persons, what fact is immediately associated with them in your mind? Answer in one or two words in each case. Mendeleef, Davy, Perkin, Faraday, Curie, Priestly, Gay-Lussac, Dalton, Solvay, Ramsay, Lavoisier.

8. How would you prepare and collect in a reasonably pure state the following gases: (a) Nitrogen, (b) Ammonia, (c) Chlorine?

9. A set of bottles was known to contain the following powdered

substance: Blue vitriol, ultramarine, manganese dioxide, carbon, potassium chloride, and potassium chlorate; but the labels on the bottles have been destroyed. What tests would you apply, mental as well as physical, which would enable you to correctly and quickly relabel the bottles?

10. If you were nailing a copper sheathing on an exposed surface what kind of nails would you use, and why?

11. Steel producing companies often have large quantities of ammonium sulphate for sale. How does the production of this subtsance happen to be connected with the iron industry?

12. Balance the following equation by inserting the proper coefficient:

$$AgNO_3 \quad Na_2HPO_4 \quad Ag_3PO_4 \quad NaNO_3 \quad HNO_3$$

13. Assume the increase in a colony of mice to be such that the number doubles every three months. How large will the colony be at the end of three years if we start with a pair?

14. The acceleration of a body outside the surface of the earth is known to be inversely proportional to the square of the distance from the center of the earth. At the surface of the earth the acceleration is 32. What will the acceleration be 50 miles above the surface? The radius of the earth is 4,000 miles.

(Write answer in form of equation but need not simplify results.)

15. A triangle, each of whose sides is six, is divided into three equal areas by drawing two lines parallel to the base. Where will these lines intersect the altitude?

QUESTIONS FROM OTHER SECTIONS OF EDISON'S EXAMINATION.

16. If you were marooned alone on a tropical island in the South Pacific without tools, how would you move a three-ton weight, such as a bowlder, 100 feet horizontally and fifteen feet vertically?

17. Two towns, on opposite sides of a river one mile wide, are cut off from communication with each other by any electrical means, due to a calamity. How would you attempt to establish communication between the two cities without the use of electricity? The river cannot be crossed by human beings.

18. What three very low forms of life can you name?

19. What is a mammoth?

20. What is a tourniquet?

21. On what physiological phenomenon is the success of motion picture projection dependent?

22. What is a meteor?

23. Name the use of the following: galvanometer, pernier, oscillograph, pantograph, micrometer, pyrometer.

24. What is the underlying principle of an internal combustion engine?

25. What is the function of the antenna in radio?

539 Restated. (16. If you were marooned alone on a tropical island in the South Pacific without tools, how would you move a three-ton weight, such as a bowlder, 100 feet horizontally and fifteen feet vertically?) Question No. 16 in Edison's list was referred to by one of the unsuccessful contestants as "idiotic." Do you agree?

SWENSON CRITICIZES SOLUTION.

527. *Proposed by Prof. Douglas I. Bates, College of Engineering, Oregon Institute of Technology, Portland, Ore.*

When the air about an organ pipe changes temperature, which changes, the frequency or the wave length of the sound, if we neglect any expansion or contraction of the organ itself?

Criticism by A. M. Swenson, Yuma, Colo.

In answer to problem 527, may I be allowed to disagree with "Contributor." The wave length of the sound emitted by an organ pipe is always twice or four times the length of the pipe, regardless of temperature. Since this is so, the frequency and therefore the pitch will rise slightly

if the temperature rises or fall with a fall in temperature. If n did remain constant as "Contributor" assumed the pitch would not change, as frequency not wave length determines pitch.

If temperature changes progressively while sound is being sent there might be a piling up of waves giving an apparent slight rise in pitch due to an effect similar to the Doppler effect.

BATES ADDS SOLUTION TO BAMBERGER'S PROBLEM.

529. *Proposed by Sudler Bamberger.*

A motorist, traveling on a level road at 40 miles per hour sees something ahead. He applies his brakes on the car and comes to a stop with a uniform acceleration. If he stops in 30 seconds, how far did he travel before coming to a stop?

Solution by Douglas I. Bates, Portland, Ore.

(1) In Re: Prob. 529, Solution (2), April issue: formula for distance should be S = avg. Vel. $\times$ time $= \frac{V+V_0}{2}t$. The use of the negative sign comes in the formula for $a = \frac{V-V_0}{2}$ and not in this formula

(2) A condensed form for this sort of problem which may be used in quizzes or lesson assignment follows:

Fill in the blank spaces with the proper values:

Problem Number	V_1 ft/sec.	V_2 ft/sec	t sec.	s feet	a ft/sec$_2$
1	50	100	3	?	?
2	50	100	?	75	?
3	50	?	2	75	?
4	?	100	2	75	?
5	50	100	?	?	2
6	50	?	2	?	2
7	?	100	2	?	2
8	50	?	?	75	2
9	?	100	?	75	—2
10	?	?	4	1000	25

These problems represent all the possible combinations of the five variables taken three at a time. Number 8 and 9 lead into quadratic equations. Number 4 gives a negative value for V_1 which indicates the accelerating body has changed directions during the two seconds.

Any one unknown may be solved for directly by one of the following formulas:

$$V_2 = V_1 + at$$
$$S = V_1 t + \tfrac{1}{2}at^2$$
$$V_2^2 = V_1^2 + 2as$$
$$S = \frac{V_1 + V_2}{2}t$$
$$S = V_2 t - \tfrac{1}{2}at^2$$

The student should select the formula which contains all of the three known variables and the one unknown variable which he desires.

THE COCOANUT PROBLEM STILL ACTIVE.

532. *Further solutions have been received from*
Glenn F. Hewitt, Fort Wayne, Ind.
Eleutherio De La Garza, Brownsville, Tex. (A second solution).

WALDORF EXPLAINS DOUBLE ANSWER.

533. *Proposed by Lloyd C. Knox, Hawarden, Iowa.*

The following problem found on page 471 of Black and Davis "Practical Physics" has given rise to a question in Mathematics:—"Two lamps give 16 and 32 candle power respectively, and are 200 centimeters apart. Where between the lamps may a greasespot photometer screen be placed so that its two sides are equally illuminated?"

Although two solutions seem possible the correct answer seems to be that given by the Square-root solution.

Explanation by G. A. Waldorf, Waukegan, Ill.

In looking over the equation 533 in May issue of SCHOOL SCIENCE AND MATHEMATICS it seems to me the following solution is correct:

$$\frac{(200-X)^2}{X^2}=\frac{32}{16}$$

$$\frac{40{,}000-400X+X^2}{X^2}=2.$$

$$2X^2=40{,}000-400X+X^2$$

$$X^2+400X-40{,}000=0.$$

By formula,—

$$X=\frac{-400\pm\sqrt{160{,}000+160{,}000}}{2}=\frac{-400\pm565.68}{2}$$

$$X=\frac{165.68}{2}=82.84\text{cm.}\qquad X=\frac{-965.68}{2}=-482.84\text{cm.}$$

(a) Are two answers possible? Strictly speaking no, because the problem asks, where *between* the lamps may the photometer be placed. The solution is 82.84 cm. from the 16 c. p. light and 117.16 cm. from the 32 c. p. light.

The other result—482.84 means that a 16 c. p. light at 482.84 cm. from a screen will produce the same intensity of illumination as a 32 c. p. lamp at 682.84 cm. If the two distances are squared they bear the relation 2 to 1.

(b) Don't see how the boy could get—200 cm. without a mathematical error, perhaps in signs, as—

$$\frac{-400+\sqrt{160{,}000-160{,}000}}{2}=\frac{-400}{2}$$

If there are any phases of this problem I have missed would be glad to know of them.

SPRAYING WITH SEA WATER.

Sea water has a new role. The Agricultural Experiment station at Guam has found that it is a cheap and effective means of killing the countless insects that gather in the folds of young, partly opened leaves of trees and shrubs. Certainly there will be no difficulty about a source of supply of the new insecticide. Palm trees, especially, have been benefited by "showers" of several gallons daily.

Complete control of the scale insect infesting the cocoanut palm has been brought about, it is said, by the introduction of predacious lady bird beetles from the Fiji Islands.—*Science News-Letter.*

AN IMPROVED ELEMENTARY METHOD FOR THE DETERMINATION OF THE HEAT OF VAPORIZATION.

By Byron E. Cohn,

Department of Physics, University of Denver, Denver, Colo.

The determination of the latent heat of vaporization of water is an experiment performed almost universally in laboratory courses of general physics. The usual simple method employed uses a laboratory boiler in conjunction with a glass steam trap and a small double calorimeter. The results obtained in an ordinary class by this method vary widely and serve to indicate that there is such a quantity as the heat of vaporization but not that it has a definite value.

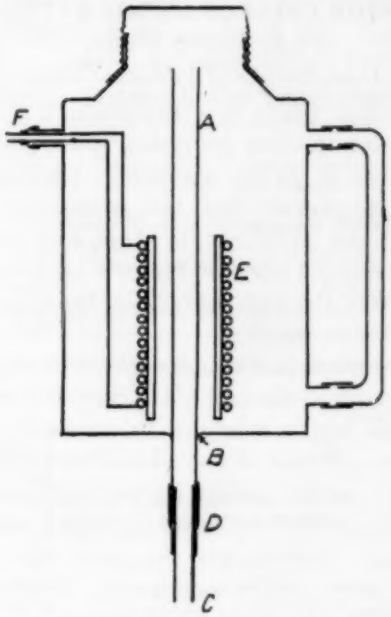
It was found that the method of M. Berthelot can be readily modified to provide a simple and yet reasonably accurate means for the determination of the latent heat of vaporization of water. The steam boiler of M. Berthelot consists of a pear-shaped flask, the bottom of which is pierced with a sealed-in glass tube whose top opening is near to the closed stem of the flask. The tube acts as the steam vent. The heat needed to vaporize the liquid is supplied by a ring burner, which allows the steam vent to pass through the burner itself. The advantage of the foregoing arrangement is that the position of the steam outlet allows the steam to pass from the flask to the calorimeter without any appreciable condensation. It is this principle that has been adapted for use in a simple laboratory apparatus.

The boiler used in the modified method is represented in section in the figure. A hole is bored in the bottom of an ordinary laboratory boiler at B. A ⅜ inch brass tube A is put through the hole and soldered at B as shown. A glass tube C is held to the brass tube A by rubber tubing D. A cylindrical heating element E wound on porcelain is slipped over the tube A. In the apparatus devised by the writer, a heating coil of the type used commercially in radiation electric heaters was employed. The heating coil E is supplied with current from the low voltage side of a 110-55 volt, 200 V. A. transformer.

The wire outlet tube F can be rendered steam tight if the wires are wrapped with tape and then pulled forcibly into the tube F. As an additional safeguard it is well to tape over the outside lead at F and onto the outside of the brass tube. To reduce the radiation heat loss from the boiler, it is wrapped with sheet asbestos.

In use the boiler is clamped in an upright position, enough

space for a double calorimeter being left below C. Current is allowed to flow in the heating coil until steam issues steadily from the glass tube C. The steam is passed into water held in the inside container of a double calorimeter in the usual manner.



Better results are obtained if the student is instructed (1) to remove any condensed moisture in C with a paper towel before starting the steam absorption (2) to be sure to touch C against the wall of the container to prevent error due to water held in C by capillarity. The boiling point is obtained indirectly from the barometric pressure.

The reason for the improvement in accuracy due to this method is of course the prevention of condensation in the vapor before reaching the calorimeter. The short glass tube C prevents any large error from heat conduction through the brass tube. The modified method was tried by a class of sixty-five students in elementary physics and of ninety unselected results, seventy-five (83%) were found to lie between 530 and 565. The mean value of H in Denver is approximately 542. A series of five determinations made by the writer, employing the thermometers and balances used in the elementary physics laboratory, gave values of 543.8, 548.7, 537.1, 541.7 and 547.8. Any of these values lies

within the limits of the error of measurement and their mean of 543.8 compares favorably with the value of 542.2 at the atmospheric pressure during the set of observations.

JUNIOR COLLEGE MATHEMATICS.

By E. Justin Hills,

Compton (Calif.) Junior College.

The Junior College today is a distinctive institution, and its rapid growth during the last few years shows its value and the interest being taken in its development. Its importance is due to the fact that its courses fulfil two functions:

1. They satisfy the requirements of the first two years of any college or university. Thus the Junior College becomes a connecting link between the high school and the specialized fields of the Junior and Senior years.

2. They serve as terminal courses for those students who discontinue college work at the end of the Sophomore year.

In view of these facts a study of Junior College curricula is a matter of vital importance in the educational field.

In mathematics lies the ground work of architecture, engineering (chiefly electrical and chemical), mining, aeronautics, and pure mathematics. Fortunately the basic courses for all these are virtually the same, which enables the Junior College to prepare its students for any of these subjects.

The purpose of this article is to show just what the public Junior Colleges of the United States are offering in mathematics, and thus to be a guide in standardizing curricula. A questionnaire was sent to 131 Junior Colleges in the United States. Of the 88 that replied, 24 were from California, 18 from Iowa, 9 from Texas, 8 from Kansas, 5 from Illinois, 4 each from Michigan and Minnesota, 3 from Missouri, 2 each from Arkansas and Oklahoma, and 1 each from Arizona, Georgia, Florida, Louisiana, Nebraska, Ohio, Pennsylvania, Tennessee, and Washington.

This questionnaire read:

1. Titles of mathematics courses open to Freshmen, with a brief statement of their content, and the prerequisites for admission. Are any of these allowed for Junior College graduation only?
2. Same for courses open to Sophomores.
3. Do you personally consider this curriculum satisfactory? Do you suggest changes?
4. Additional remarks.

The first two questions brought out the following facts. (There

being practically no distinction between Freshmen and Sophomore courses other than order of precedence, no attempt is made here to classify according to year.)

1. Academic courses in Mathematics.

Courses	*Number of Junior Colleges Offering*
Elementary Algebra	3
Plane Geometry	4
Solid Geometry	14
Intermediate Algebra (Advanced High School Algebra)	28
Trigonometry	84
College Algebra	83
Analytic Geometry	80
Differential Calculus	76
Integral Calculus	71
Solid Analytic Geometry, Multiple Integrals, Infinite Series, and Differential Equations	17
Differential Equations (separate course)	5
Projective Geometry	3
Theory of Equations	3
General Astronomy	3

2. Mathematics courses of an occupational character.

a. Commerce

Courses	*Number of Junior Colleges Offering*
Mathematics of Finance	24
Statistical Methods	4
Business Mathematics (terminal course)	3

b. Engineering, Industrial, and Aeronautical.

Courses	*Number of Junior Colleges Offering*
Descriptive Geometry	13
Analytic Mechanics	10
Plane Surveying (year course)	8
Plane Surveying (semester course)	3
Plane Surveying (summer course)	1
Slide Rule	7
Applied or Shop Mathematics (terminal course)	4
Sketching and Drafting Room Practice	1

c. Pre-Teaching.

Courses	*Number of Junior Colleges Offering*
The Teaching of Arithmetic in the First Six Grades	1
The Teaching of Arithmetic in the Seventh and Eighth Grades	1
Teachers' Arithmetic	1

These statistics show that the mathematics most commonly taught in the academic courses of these 88 Junior Colleges are, in order of frequency:

Trigonometry (84); College Algebra (83); Analytic Geometry (80); Differential Calculus (76); Integral Calculus (71); and Intermediate Algebra (28).

In Commerce, Mathematics of Finance has the highest score. This is undoubtedly due to it being the mathematics course required for Pre-commerce students.

In Engineering, Descriptive Geometry (13) and Analytic Mechanics (10) are found to be given oftenest.

Only two Junior Colleges offer Pre-Teaching courses. In those states where college graduation is not necessary for a teacher's credential the Junior College can play a real part in the training of teachers.

By grouping the courses one can show clearly what most of the Junior Colleges present.

Junior Colleges giving:

Courses	*Number of Junior Colleges Offering*
Trigonometry, College Algebra, and Analytic Geometry	76
Analytic Geometry, Differential and Integral Calculus	67
Trigonometry, College Algebra, Analytic Geometry, Differential and Integral Calculus	65
Intermediate Algebra, College Algebra, Trigonometry, Analytic Geometry, Differential and Integral Calculus	27
Intermediate Algebra and Trigonometry	25
Intermediate Algebra, Trigonometry, and Solid Geometry	11

The figures show certain facts of interest:

1. 76 Junior Colleges offer Trigonometry, College Algebra, and Analytic Geometry. 36 offer these as a unified course for all those who need mathematics. In the States where such courses are offered Trigonometry is not given in high school.

2. 67 Junior Colleges offer the standard Freshmen and Sophomore college academic courses, namely Analytic Geometry, Differential and Integral Calculus. Only two of these do not offer also Trigonometry and College Algebra.

3. Only 11 Junior Colleges offer the standard Junior and Senior high school mathematics, namely Intermediate Algebra, Trigonometry and Solid Geometry, though 25 offer the first two mentioned.

4. Only one Junior College, offering Intermediate Algebra, does not also offer College Albegra, Trigonometry, Analytic Geometry, Differential and Integral Calculus.

No attempt has been made to classify the courses according to credit given, as that varies to some extent and is regulated primarily by the respective state universities. Analytic Geometry, for instance, is offered as a five unit, four unit, or three unit course though the content seems very much the same.

Elementary Algebra and Plane Geometry are offered, with no credit, to students who have taken no mathematics in high school. Two Junior Colleges offer Junior College graduation credit, but not transfer credit.

At present Business and Applied or Shop Mathematics are

accepted in Junior Colleges only for credit in the terminal curricula.

Of the 88 Junior Colleges that reported, only 15 were not satisfied with their present program, though several were anxious for additional information and suggestions. The chief criticism was in reference to the lack of foundation work in the high school mathematics. Two ways were suggested by which this could be remedied.

The first way was to require attendance more hours than a class is credited for. Thus several Junior Colleges require five hours attendance for either three or four hours credit. By doing so supervised study can be introduced. If the student shows that he can do the work in three or four hours some institutions permit him to come only as often as that.

The other remedy is to limit the enrollment to those students who have the ability to do the work well. This can best be accomplished by selecting the students that receive the two highest grades of the five usually given in high school. For those who are not so prepared, but who wish to take more mathematics, a review course should be offered, without credit.

In the question: Are any of these allowed for Junior College graduation only? the writer was thinking of terminal curricula. The reports showed that only five Junior Colleges offer terminal courses. This is undoubtedly due to the fact that most Junior Colleges can not be termed independent. Being merely stepping stones, they offer only what the state university will accept. But as they grow larger some freedom of choice is shown, and undoubtedly as time goes on those students who do not care to go to the Junior year will be able to get more definitely terminal material.

All courses of an occupational character can be called terminal. However, all except one or two such courses require a considerable mathematical foundation. Many students who lack ability and preparation want terminal work. A course in Business Mathematics or Shop Mathematics would probably just suit their needs. Both courses avoid Algebra, yet use its methods in developing the subject.

The writer has drawn up the following chart as a suggestion for a mathematics curriculum. It does not differ greatly from the program that prevails most commonly now in the Junior Colleges, as shown by the replies to the questionnaire. Only those courses of first importance have been included.

Preparation	First Semester	Second Semester	Third Semester	Fourth Semester
1½ or 2 years of Algebra 1 or 1½ years of Geometry ½ year of Trigonometry	Analytic Geometry College Algebra (optional)	The Calculus		Solid Analytic Geometry, Higher Calculus, Infinite Series, and Differential Equations
1½ or 2 years of Algebra 1 or 1½ years of Geometry	Freshmen Mathematics: College Algebra (13 weeks) / Trigonometry (10 Weeks) / Analytic Geometry (13 weeks)			The Calculus
1 year of Algebra 1 year of Geometry	Intermediate Algebra	Trigonometry Mathematics of Finance	Analytic Geometry College Algebra (optional)	The Calculus (first half)
None	Elementary Algebra	Plane Geometry	Intermediate Alge-Algebra	Trigonometry Mathematics of Finance

This particular arrangement has as its primary value the fact that all students who have had at least three years of high school mathematics, including Trigonometry, can immediately start regular college work. In this group should be all those whose future work requires a mathematical foundation.

When students enter the Junior College with only two years of high school mathematics, they find themselves a year behind in their regular college work. Intermediate Algebra is suitable for them and for Pre-Commerce students (since it must precede Mathematics of Finance, the only mathematics course in their college curriculum).

Where students are unable to get Trigonometry in high school the Freshmen Mathematics program just suits them.

Those students entering with no mathematics are greatly handicapped. Most States require two years of Mathematics in order to graduate from High School, which lessens this difficulty. But where the students can graduate without the basic courses it becomes the duty of the Junior College to offer Elementary Algebra and Plane Geometry, if they need them in order to transfer to a higher institution.

Many other courses could be included. Their introduction should depend entirely on demand and the ability of the Junior College to offer them. If courses can be added, the most logical order of introduction seems to be Solid Geometry (a basic course for Pre-Engineers that high school graduates seldom have had); Descriptive Geometry (a course that should parallel the third or fourth or the third and fourth semesters of the regular college mathematics course); Analytic Mechanics (a course that follows Integral Calculus); Plane Surveying (either as a year course for three units credit each semester or a semester course for five units credit according to locality with a prerequisite of Trigonometry); Theory of Equations (a course that should receive greater emphasis).

As yet no attempt seems to have been made to offer a review course in Algebra, Trigonometry, and the elements of Analytic Geometry. Such a course, without credit, might be required of students failing in Analytic Geometry, before they are allowed to repeat. Such a plan is being followed in Chemistry, Physics, Language, and English, in some States, and will probably be introduced into other fields.

The writer has not attempted to discuss the content of any of these courses. The surprising uniformity in the choice of textbooks appears to indicate that the content of most of these courses does not differ greatly in the various Junior Colleges.

BREED MICE IN COLORS.

"Colored Mice to Match Your Dresses" may be a popular fad some day if the predictions of Smith College Zoology students come true. Even now the members of one of the zoology classes will guarantee you mice of any one of five different shades.

The class has been concentrating on experiments on the inheritance of color. All mice are descended from ancestors of a single color, "agouti," or the grayish-brown which conceals them so well in the woods. By breeding it is possible to isolate the new color patterns in pure hereditary form and then to predict the proportions in which they will occur in the offspring. So when a student crosses a black mouse with a yellow mouse she is usually able to predict mathematically what color the young will be, and how many there will be of each color.

Sometimes, however, "mutations" occur. These are mice of a color different from that of either parent, whose offspring also will be of this new color.—*Science News-Letter.*

EASTERN ASSOCIATION OF PHYSICS TEACHERS ADOPTS SCHOOL SCIENCE AND MATHEMATICS AS ITS OFFICIAL ORGAN.

At a recent meeting the Executive Committee of the Eastern Association of Physics Teachers voted to adopt SCHOOL SCIENCE AND MATHEMATICS as its official journal. The reports of all meetings of the Association will now be published in the issue following the meeting and membership will include subscription to the journal. This organization has been a very important factor in promoting the teaching of physics and our readers will always find valuable information and new ideas in these reports. This type of cooperation in education always brings benefits to all concerned.

The program given below, which unfortunately was received too late for publication in the October issue, will forecast the subject matter of the first report under this arrangement.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Thirteenth Meeting, Saturday, November 2, 1929

Jefferson Physical Laboratory, Harvard University

MORNING PROGRAM

9:30 Meeting of Executive Committee

9:45 Business Meeting: Reports of Committees

10:15 Tribute to Professor Herman Hahn of Berlin
Prof. N. Henry Black, Harvard University

10:30 "What Is the Nature of Light": with Experimental Demonstrations
Dr. Franze H. Crawford, Harvard University

11:30 "Modern Methods of Producing High Vacuum and Various Phenomena of Electron Emission in High Vacuum" with Experimental Demonstration
Mr. E. L. Manning, Research Laboratory, General Electric Laboratory, Schenectady, N. Y.

2:00 Foot Ball Game at Harvard Stadium
Harvard Florida

ULTRA-VIOLET RAYS SHOW AGE OF STATUES.

The uncanny skill with which X-rays have sorted out paintings of old masters from upstart modern copies may now be duplicated by ultra-violet rays working in the field of sculpture. In a series of tests made by the Metropolitan Museum of Art, pieces of old Carrara marble were compared with freshly cut Carrara under the ultra-violet light. A decided difference in color was noted.

Pieces of marble statues, some antique, some known to be modern or fraudulent, were then put to the ultra-violet test, and in every case the rays gave the same verdict that experts have reached by careful observation. One Roman portrait head of a young girl was immediately condemned by the lights. On checking the record of this statue it was found to be a modern work by Dossena, whose success in imitating antique sculpture has caused much excitement in art circles. The surface of the head had been altered by baking the marble and then pitting it with a ragged stone, but the powerful light could not be fooled by recently cut marble. Further, the test showed that the three portions of the broken statue are all of the same age, which settles the argument that part of the figure might have been old and the rest supplied by a modern workman.

When the rays were turned on some fifteenth-century marbles they detected breaks in the stone that had been long ago patched and painted so skilfully that experts had never noted the repairs.

Great usefulness for the ultra-violet light in this new field is predicted, but the museum experts warn that there will still be need for careful judgment and experience in interpreting the facts that the light may reveal.—*Science News-Letter.*

BROOKLYN BOTANIC GARDEN MEMOIRS

Volume I: 33 contributions by various authors on genetics, pathology, mycology, physiology, ecology, plant geography, and systematic botany. Price, $3.50 plus postage.
Volume II: The vegetation of Long Island. Part I. The vegetation of Montauk, etc. By Norman Taylor. Pub. 1923. 108 pp. Price, $1.00.
Volume III: The vegetation of Mt. Desert Island, Maine, and its environment. By Barrington Moore and Norman Taylor. 151 pp., 27 text-figs., vegetation map in colors. June 10, 1927. Price, $1.60.

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BOOKS RECEIVED.

Principles of Animal Biology by A. Franklin Shull, Professor of Zoology in the University of Michigan with the collaboration of George R. Larue, Professor of Zoology in the University of Michigan and Alexander G. Ruthven, Professor of Zoology and Director of the Museum of Zoology in the University of Michigan. Third Edition. Cloth. Pages xiv+405. 14.5x23 cm. 1929. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $3.50.

Plane Geometry by Joseph A. Nyberg, Instructor in Mathematics, Hyde Park High School, Chicago, Ill. Cloth. Pages viii+292. 12.5x18.5 cm. 1929. American Book Company, Chicago, Ill.

Mathematics Preparatory to Statistics and Finance by George N. Bauer, University of New Hampshire. Cloth. Pages vii+337. 12.5x19 cm. 1929. The Macmillan Company, New York. Price $2.00.

Plane Trigonometry by Ernest Jackson Oglesby and Hollis Raymond Cooley of The Department of Mathematics, Washington Square College, New York University. Cloth. Pages ix+150+76. 15x23 cm. 1929. Prentice-Hall, Inc., 70 Fifth Avenue, New York. Price $1.60.

The Alpha Individual Arithmetics by The Supervisory Staff of The Summit Experimental School, Cincinnati, Ohio, and illustrated by Kayren Draper. Paper. Book Two, Part I and Book Two, Part II have vii+136 pages each. 17.5x23 cm. 1929. Ginn and Company, 15 Ashburton Place, Boston. Price each 36 cents.

Modern Mathematics by Raleigh Schorling, Head of Department of Mathematics, The University High School and Professor of Education, University of Michigan and John R. Clark, The Lincoln School, Teachers College, Columbia University. Seventh School Year, New Edition. Cloth. Pages xiv+274. Illustrated. Price 88 cents. Eighth School Year, New Edition. Cloth. Pages xiv+306. Illustrated. Price 92 cents. World Book Company, Yonkers-on-Hudson, New York.

Organic and Food Chemistry by Garry Eugene Culver and Thomas Arthur Rogers, Central State Teachers College, Sevens Point, Wisconsin. Cloth. Pages vii+212. 13x19.5 cm. 1929. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $1.50.

Elements of the Differential and Integral Calculus by William Anthony Granville, Formerly President of Gettysburg College; revised by Percey F. Smith and William Raymond Longley, Professors of Mathematics at Yale University. Cloth. Pages xi+516. 15x23.5 cm. 1929. Ginn and Company, 15 Ashburton Place, Boston. Price $3.20.

General Science by Richard W. Sharpe, George Washington High School, New York City. Paper. Pages v+230+19. 12.5x19 cm. 1929. Oxford Book Company, 111 Fifth Avenue, New York. Price 68 cents plus 4 cents postage.

Solutions of Electrolytes with Particular Applications to Qualitative Analysis by Louis P. Hammett, Associate Professor of Chemistry in Columbia University. First Edition. Cloth. Pages ix+211. 14x20.5 cm. 1929. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $2.25.

A Biology Workbook by James C. Adell, Chairman of the Biology Division, Lincoln High School, Cleveland, Ohio, Orra Olive Dunham, Chairman of the Biology Division, Collinwood High School, Cleveland, Ohio, and Louis E. Welton, Head of the Science Department, John Hay High School, Cleveland, Ohio. Paper. Pages vi+325. 18.5x26.5 cm. 1929. Ginn and Company, 15 Ashburton Place, Boston. Price $1.32.

Geometry Work-Book by H. D. Welte, Principal of the State Normal School, New Britain, Connecticut, and F. B. Knight, College of Education, University of Iowa, Iowa City, Iowa. Paper. Pages iv+74. 20x28 cm. 1929. Scott, Foresman and Company, 623 So. Wabash Avenue, Chicago, Illinois. Price 44 cents.

Teaching Aids for the Asking selected by Homer J. Smith, Associate Professor of Industrial Education, University of Minnesota. Paper. 62 pages. 15x23 cm. 1928. The University of Minnesota Press, Minneapolis, Minnesota. Price 50 cents.

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BOOK REVIEWS.

Algebra for Today, by William Betz, Vice-principal of the East High School and Specialist in Mathematics for the Public Schools of Rochester, New York. Pp. x+472+46. 14.5x19.5 cm. 1929. Ginn and Co., 15 Ashburton Place, Boston, $1.32.

Every teacher of mathematics should be alive to the fact that mathematics plays a fundamental role in our modern civilization. He should not only have direct knowledge of its applications to the problems of many different fields, but should also be able to point out, again and again, to his students illustrations of these applications. Not only the teacher but also the text placed in the hands of the pupil should be charged with the idea that mathematics, like chemistry, physics, and other sciences, lies at the foundation of our modern industrial progress. In this text the author has repeatedly stressed this idea. In fact each of the first seven chapters begins with a paragraph setting forth in an interesting manner the practical importance of the topic under discussion.

Other features of the text are summarized by the author as follows:

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(1) The language and the ideas of algebra, (2) The Formula, (3) The Equation, (4) The Graph, (5) Fundamental Principles and Processes, and (6) Problem Solving.

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5. Each chapter represents a fairly complete "unit" of work.

6. Material for development lessons is presented at critical points.

7. The exercises are carefully graded. Definite provision is made for informal oral work.

8. Practice exercises and tests are liberally provided wherever they seem most useful.

9. Problem solving receives due emphasis throughout the course.

10. Each chapter contains a summary of specific objectives; a general summary and review is given at the end of the book. J. M. Kinney.

Modern Plane Geometry, by John C. Stone, Professor of Mathematics, State Teachers College, Montclair, N. J., and Virgil S. Mallory, Assistant Professor of Mathematics, State Teachers College, Montclair, N. J., formerly Head of the Department of Mathematics, East Orange High School, N. J. Pp. xv+474. 14.5x19.5 cm. 1929. Benj. H. Sanborn and Company, 221 East 20th Street, Chicago, Ill. $1.40.

This book has many interesting features. It is organized on the unit plan. There are eight units of which each deals with material that is closely related. The first unit is devoted to intuitional geometry. Here the foundation for the formal work which is introduced in the second unit is very carefully laid.

At the end of each unit a review is provided for the unit. General exercises which call for application of the knowledge gained in preceding units follow this review. At the end of each second unit, we find various objective tests, such as numerical exercises, multiple-choice, true-false, completion, matching, and construction.

One method of proof is presented at a time and practice in using it is continued until facility is acquired.

Considerable attention is given to practical applications. These include problems in navigation, astronomy, surveying, mapping, architecture, designing, and art. These are, also, numerous illustrations showing geometrical designs in nature and how geometrical principles are applied in church windows, tiles, laces, linoleums, and other forms of art in industry. J. M. Kinney.

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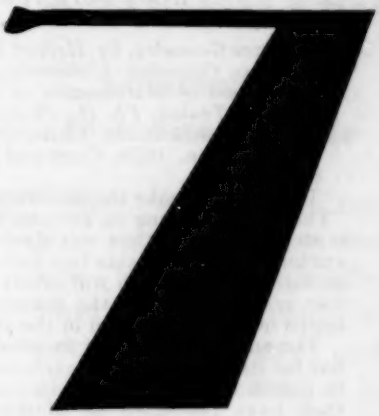

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New Plane Geometry, by Herbert E. Hawkes, Ph. D., Professor of Mathematics in Columbia University; William A. Luby, A. M., Head of the Department of Mathematics in the Junior College of Kansas City; and Frank C. Teuton, Ph. D., Professor of Education and Director of Educational Research in the University of Southern California. Pp viii+428. 14.5x19.5 cm. 1929. Ginn and Company, 15 Ashburton Place, Boston. $1.32.

The authors make the following introductory statement in the preface: "The student taking up geometry for the first time faces a subject which is stranger to him than was algebra when he was fresh from the study of arithmetic." With this fact before them they have carefully developed an introduction which will orient the student for his work in demonstrative geometry. Here the student becomes familiar with the tools and learns how they are used in the theorems and proofs of formal geometry.

The authors have kept in mind the fact that demonstrative geometry has for its chief aim the development in the mind of the pupil an ability to reason from hypotheses to conclusions. At the same time, however, they have presented an abundance of material which illustrates its practical applications in mensuration, physics, trigonometry, architectural design, and decorative problems. J. M. Kinney.

The Psychology of Learning Applied to Health Education through Biology, by Anita Duncan Laton, Ph. D., Teachers College, Columbia University, Contributions to Education, No. 344. Pp. 103. Bureau of Publications, Columbia University, New York City. 1929. Cloth, $1.50.

This book is a report of a study which was conducted under actual school conditions in the Lincoln School of Teachers College, New York City. It represents an attempt to apply the facts and principles established by work in the psychology of learning to one unit in junior high school biology, where teaching has been directed toward health education as an objective rather than toward mastery of subject matter.

The four parts of the study include, first, choice of specific health objectives and subject matter, second, the relation of these objectives and subject matter to the objectives and subject matter of biology, third, teaching procedure, and fourth, testing to determine whether the objectives had been attained.

Definite conclusions were reached as a result of the study, and while these are important in their more or less general bearing, yet the greatest value of this analysis lies in the fact that it is an illustration of how a comprehensive study of this type may be carried out. The work is especially valuable since the technique is directed toward the achievement of an objective other than mastery of specific facts.

Jerome Isenbarger.

Reference Book of Inorganic Chemistry by Wendell M. Latimer, Associate Professor of Chemistry in the University of California, and Joel H. Hildebrand, Professor of Chemistry in the University of California. 1st Edition. viii+442. 3x15x22 cm. Many tables, some curves, figures of space lattices. Cloth. 1929. The Macmillan Co.

This book is the last of the series which was begun by "Principles of Chemistry" by Hildebrand and continued with the "Course in General Chemistry" by Bray & Latimer, which furnishes a laboratory course. The material covered is largely that which our more voluminous texts crowd into the last half of the book. A perusal of some of the material shows that it is much more readable than is usually the case with descriptive chemistry. Much use of the sub atomic structure theory is made from the first. The order of treatment is that of the periodic arrangement, the authors leaving to each teacher the chance to teach the material in any order that he chooses, numbering the paragraphs in each chapter separately so that assignment of material may be facilitated.

The book, while primarily intended to be used as reference book in general inorganic chemistry courses, will be found most valuable as a reference library book for high school chemistry departments and as a personal reference book for teachers and for industrial chemists. F.B.W.

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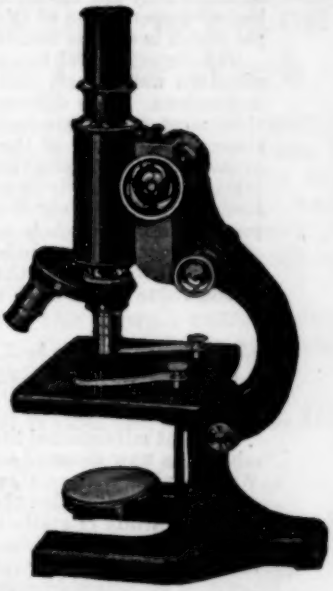

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Dynamics by A. S. Ramsey, M. A., President of Magdalen College, Cambridge; and University Lecturer in Mathematics. Cambridge at the University Press. 1929. pp. xii+259.

Ramsey's Dynamics is a book prepared for students of British Universities and particularly for those who intend to take an Honours Course of Mathematics at a University or a first Honours examination. The book, despite the above high sounding description, can be considered, with but a few exceptions, as a text book of *Elementary* Dynamics and does not require for its reading more mathematical equipment than the ability to understand the simplest type of differential equations. As a text book it seems best adapted to the work of junior students in our colleges.

The book which, parenthetically, is an example of excellent printing, is divided into twenty-seven chapters including an introductory chapter. They are short and each is devoted to a definite topic of dynamics. Each chapter can be properly divided into three parts containing first, the analysis of the topic, second, the solution of numerous illustrative problems, and third, a great number of problems and theorems, many of which are of the type used in actual practice by engineers, to be worked out by the students.

The choice of the material to be included in a text-book dealing with such an immense subject is as important as its treatment. Among the great number of theorems and problems which can be included the author must make a careful choice and elimination, and it seems to me that Professor Ramsey, in writing his Dynamics, has shown rare judgment. His book is *modern* if such an expression is permissible in connection with as classical a subject as Dynamics. It is modern in the sense that it follows the needs of modern physics and it includes, conserving always its elementary character, chapters on Orbits and the dynamics of Rigid Bodies.

An outstanding characteristic of the book is the simplicity with which the meaning of the equations of dynamics is translated into words. To mention only one instance, the writer does not know of a simpler or more logical presentation of D'Alembert's principle on effective forces; a principle which is seldom satisfactorily explained.

The experimental bases of the fundamental laws of dynamics are emphasized and clearly distinguished from the ensuing purely theoretical deductions. This differentiation is very important in view of the fact that most of the students confuse these two elements and see, for instance, in the case of the vectorial addition of forces or in the parallelogram law, a mathematical necessity and fail to realize that the mathematics is used simply to express certain experimental facts in a convenient form. Unfortunately it is only too true that in many cases the experimental basis of a whole science is lost, for the students, in the wilderness of mathematical symbols.

In fine I want to add that a great number of careful drawings add greatly to the value of the book and help to make the subject matter clearer.

Ph. A. Constantinides.

Elementary Statistics by J. Harold Williams, Associate Professor of Education, University of California at Los Angeles. Cloth. Pages xvi+220. 13x19.5 cm. 1929. D. C. Heath and company, Boston, Mass. Price $2.00.

Current educational literature and many of the introductory courses in education now demand some knowledge of statistical methods. Professor Williams has written this elementary book to provide beginning students of education, and also those teachers whose professional training did not include a study of statistics, with the essentials of this subject.

He has carefully defined all technical terms and explained their use in illustrative problems completely solved. These are followed by a list of practice problems arranged in order of difficulty. It is in reality a manual of elementary statistics which may be followed without instruction. Since practically all theory is omitted the book is not adapted to the needs of advanced students.

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Direct Current Electricity by L. Raymond Smith, Instructor in Industrial Physics, Dickinson High School, Jersey City, N. J. First Edition. Cloth. Pages xi+262. 12x19 cm. 1929. McGraw-Hill Book Company, Inc., New York. Price $2.00.

This is the third book of a series on Industrial Physics, the two preceding being Mechanics and Heat. It is written for beginners in electricity who are preparing for work in the electrical trades. To adapt it for this purpose the author has used simple, non-technical language throughout and has included an unusual number of drawings and pictures, 272 illustrations in all. At the close of each chapter is a very detailed list of questions based on the topics of the chapter. These will test the student on the efficiency of his reading and bring out many ideas he has missed. They are also very convenient for the teacher in making assignments. Numerical problems are numerous; some of these follow immediately the laws which they illustrate and others at the close of the chapters are more involved and depend upon a combination of several principles that have been previously discussed. In this manner the author has developed a method for easy mastery of the fundamental ideas of electricity and has provided for continuous review. The book is very well adapted to accomplish its purpose. It is an elementary discussion of the principles of direct current electricity, presented in an effective manner and explained in accordance with modern theory.

G. W. W.

Organic and Food Chemistry by Garry Eugene Culver and Thomas Arthur Rogers, Central State Teachers College, Stevens Point, Wisconsin. Cloth. Pages vii+212. 13x19.5 cm. 1929. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $1.50.

A text in organic and food chemistry is a difficult work to make presentable to a class of students. The problem presents itself as to what to include and what to omit from a vast assortment of material. The authors have chosen their material from among those most used in the household. They also have avoided the unsound procedure of presenting just another book of food tests without presenting at the same time an understanding of the chemical principles involved. The book presents itself admirably to a class in domestic science. The material is not too technical to confuse the student, and yet it is scientifically sound. Such texts are not too plentiful.

This book is the result of the experiences of both authors in teaching the subject to Domestic Science classes from typed notes through quite a long period of time. The authors therefore, have succeeded in presenting those topics most suitable for a class in domestic science.

The first eight chapters contain the traditional presentation of the aliphatics with experiments. Beginning with the marsh gas series, the halogen derivatives, alcohols, ethers, aldehydes and ketones, organic acids and esters follow. The subject matter in these chapters, which makes up about one half of the book, is clearly and simply stated; numerous formulations make for ease of understanding on the part of the student. The remaining portion of the book deals with the essential oils, soaps, carbohydrates, baking powders, cyclic compounds, compounds of nitrogen, digestion, vitamines, water supply, tea and a chapter on thermo-chemistry. Questions for review and study end each chapter. An appendix consisting of food tables, a classification of proteins and amino acids and a list of books consulted are included in the text. More space might have been given to the vitamines due to their growing importance, and mention might have been made of the dangers involved in such habit forming drugs as acetanilid and acepheneditin, due to their growing indescriminate use. Elementary discussions on such topics as the physiological effects of ethyl alcohol, glucose as a food, and metabolism, not to mention others, give the book an interesting touch.

Being well bound and of bold type, compact and not too bulky to fit the pocket makes the book more inviting to the busy student. As a whole, this book appears to possess real merit. Walter McCrory.

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Smith's College Chemistry, by James Kendall, F. R. S. Professor of Chemistry in the University of Edinburgh; formerly Professor of Chemistry at Columbia University and at New York University. Revised edition. Pp xii+759. 4x15x22 cm. Illustrated. Cloth. 1929. $3.75. The Century Co.

A revision down to date of the well known Smith text by the now equally well known Professor Kendall, who has previously revised the Smith book (in 1923).

The major changes in the text concern the subjects of atomic and molecular weights and, being in the act of teaching those subjects to a selected group of bright students when the new text arrived the reviewer was interested to scrutinize the method rather intensively (finding it excellent, too). The chapter on atomic structure has been put forward in the new arrangement so that it may be used thereafter. The modern views in regard to the ionization of strong electrolytes have been well presented.

Of course there have been many minor changes introduced. Those college teachers who are giving "real honest to goodness" courses in general inorganic chemistry will find the new Smith-Kendall text hard to beat.

A Laboratory Outline of Smith's College Chemistry, by James Kendall, F. R. S. etc. Revised Edition. To accompany the above text. This revised manual is of larger page size than its predecessor in order that there may be more of blank page space for brief notes on the experiments. It has all of the excellence of its previous edition plus some improvements. F. B. W.

Introduction to College Physics by Clinton Maury Kilby, Professor of Physics in Randolph-Macon Woman's College, Lynchburg, Virginia. Cloth. Pages vii+349. 13.5x21.5 cm. 1929. D. Van Nostrand Company, Inc., New York. Price $3.00.

This textbook of physics was written to fill the need of colleges offering a short course in physics. It covers the fundamentals of the subject so that the student may acquire a foundation for future physics courses or a knowledge of the physics principles necessary in other sciences without the necessity of daily work for a full year. The author has followed the order of treatment that became the accepted order some years ago, i. e. he starts with a discussion of the properties of matter and follows with kinematics, dynamics and hydromechanics in order. He justifies this plan by stating that the most fundamental should come first and even tho it is difficult the student's mind is more alert and active at the beginning of the year than later especially during the "spring fever" period.

Although the classic order of treatment obtains it does not follow that the new physics has been omitted. Wherever recent discovery has caused a revision of the old theories the author has made his discussion in terms of present knowledge. The language is clear and simple, but from this it must not be inferred that all mathematics has been omitted. Algebra and trigonometry are used wherever they are necessary or valuable in giving definiteness and to assist the student to complete understanding of principles and their applications. Completely solved illustrative problems are frequent and lists of practice problems are included in many of the chapters. G. W. W.

Principles of Animal Biology, Third Edition, by A. Franklin Shull, Professor of Zoology in the University of Michigan, with the collaboration of George R. Larue, Professor of Zoology in the University of Michigan, and Alexander R. Ruthven, Professor of Zoology and Director of the Museum of Zoology in the University of Michigan. 405 pages, 265 figures. McGraw Hill Book Company, Inc., 370 Seventh Avenue, New York. $3.50. 1929.

The first edition of this text appeared in 1920, the second in 1924. The general plan of the first edition was retained in the second edition and is followed in the third edition. The title of the book indicates the method of treatment and principal emphasis. The authors have been eminently successful, from the start, in producing a book on the basis of

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principles, breaking away completely from the type form plan. The emphasis is placed throughout on biological principles rather than on animals.

The introductory chapter gives an outline of the historical background of the study of biology. Historical phases of the subject are also woven into the text along with the subject matter, as in the study of the cell, the chapter on classification, and along with the work in genetics and evolution.

The organization of the text is such that it would work in very nicely with a course planned on the Morrison idea of units. This, in itself, is proof that it embodies a carefully selected and arranged content of material. Three chapters are given to a study of the morphology, physiology, and division of the cell. The two following chapters are given to a study of development of tissues, with something of function, in lower and higher animal forms. Two chapters are devoted to physiology of the higher forms. Four chapters are used in a study of reproduction, breeding habits, and embryonic development of animals and of genetics. A chapter discusses the principles of classification. An introduction to animal ecology and geographic distribution is given in two chapters. Two chapters are used in the treatment of the subjects of fossil animals and organic evolution.

Among improvements that the latest edition shows are changes made in the chapter on genetics which now includes an excellent list of problems. No treatment in genetics for use in elementary college classes in biology is complete without a list of problems and exercises to be worked out by the student.

An excellent glossary is provided at the end of the book. This adds much to the value of the book as a text and as a reference. As a matter of fact, neither the student nor the teacher has always a dictionary at hand that will give satisfactory definitions and explanations of biological terms.

The book is well written and, kept up to date as it is, it is thoroughly reliable as to statement with regard to fact or theory. The publishers of this series of texts are to be complimented on their selection of paper used and the general mechanical make-up of the various books.

Jerome Isenbarger.

Prevention of Disease in the Individual, by Kenelm Winslow, Attending Physician to Seattle City Hospital and King County Hospital, Washington. Third edition. Foreword by Dr. Chas. H. Mayo. Pp. 430, 22 figures. W. B. Saunders Co., Philadelphia. 1929.

The modern trend of medicine is directed toward prevention rather than cure of disease. The business of the modern physician is becoming more and more that of educating the public on how to keep fit. This book is strictly in line with the modern movement toward a better understanding of the laws of health and principles of disease prevention.

The emphasis is placed on hygiene as a personal responsibility. The first three chapters of the book deal with the general phases of personal hygiene, as selection of foods, care of the teeth and mouth, selection of clothing and care of the skin. Four following chapters take up the study of the germ diseases. There is a chapter devoted to the subject of prevention of cancer and another on the prevention of sexual disease and on sexual hygiene. Eight chapters are devoted to the prevention of specific diseases and to the correction of abnormal conditions. The last two chapters of the book are concerned with prevention of deformities, as stoop shoulders and weak feet, and with methods to be used in administering first aid in case of accident.

The book is written for adults. It provides a mass of information about causes of disease and gives measures to be used in prevention of disease. It is specific rather than general in its treatment of the subject. It is to be noted that the book is written by a practicing physician. The work shows that the author understands thoroughly the type of information which the layman should have to supplement that which can be supplied by the physician and diagnostician in active practice in the community.

Jerome Isenbarger.

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Memoranda of Toxicology by Max Trumper, Consulting Clinical Chemist and Toxicologist. In Charge of Pyscho-Biochemistry Laboratory, Graduate School, University of Pennsylvania. Second Edition. Cloth. Pages xii+214. 11x15.5 cm. 1929. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $1.50.

Students of toxicology will find in this book material which has kept pace with recent advances in the fields of pharmacology, physiological and pathological chemistry. The author states that the results of American research figure largely in this book. This is evident throughout the work.

Recent findings on poisoning from methyl chloride gas, fundamental advances in combating respiratory depression by the use of carbon dioxide gas, and newer sources of poisoning, such as tetrethyl lead, asphyxiating gases, and barium salts have been thoroughly considered. A considerable amount of the newly developed views in regard to antidotes and methods of treatment are also included.

The book is recommended to those seeking the latest findings in the field of toxicology.

Walter McCrory.

SHINING FLY PAPER.

Luminous fly paper that lures light-loving flies to a sticky doom may soon be in use, Lyman Chalkley, Jr., director of research of Pedlar and Ryan, New York, told the Illuminating Engineering Society. Phosphorescent pigments mixed with the sticky coating produces a light when the fly paper is in the dark.

"Photoluminescence is finding an increasing number of industrial applications," Mr. Chalkley explained. "Phosphorescent materials, that emit light for some time after the exciting light has ceased, are used on lifebuoys, signboards and house numbers."

Fluorescent materials which glow only while under the influence of an activating light are also finding use. When illuminated by ultraviolet light, itself invisible to the eyes, they produce visible light used effectively on the stage and in window displays. By combining phosphorescent and fluorescent pigments in costumes or signs, striking effects can be obtained. —*Science News-Letter.*

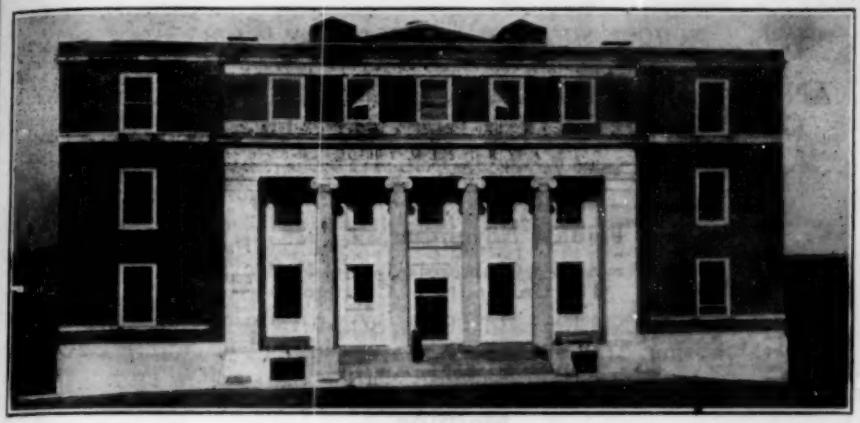
CAVE MAN'S BRAIN FOUND.

A rare find of human brains, representing our ancestors thousands of years ago, has been announced from Odinzowo, near Moscow, in central Russia. The two petrified brains were found associated with the teeth of a woolly mammoth, and they are without doubt the very oldest fossilized human brains ever found.

It is reported that a commission of scientists has been selected to make detailed studies of these remarkable finds of man during the ice age when the huge mammoths and the rhinoceros were clothed with a thick coat of wooly hair.

These rare finds are not "casts," but actually petrified human brains—somewhat shrunken, to be sure, but sufficiently well preserved so that anatomists can reconstruct the form of the brains from the fossils.

The cave man was equipped with a goodly supply of gray matter. The Russian scientist, Hindze, who is preparing a report on the fossil brains, is of the opinion that man in the ice age possessed a brain slightly smaller and less developed than recent dwellers of the same area.—*Science News-Letter.*



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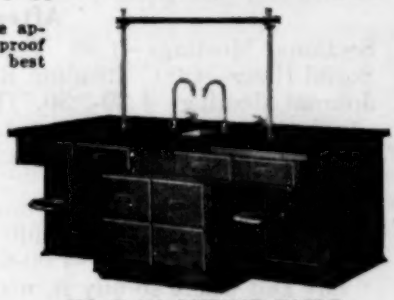

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ANNUAL MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

GENERAL PROGRAM

Friday, November 29, 1929

Reynold's Club and Mandel Hall,
The University of Chicago

REGISTRATION—Reynold's Club, 8:15-9:15 A. M.
General Session, Mandel Hall
Admission by Card

Morning

ORGAN RECITAL—9:15-9:30.
JAMES W. HOGE, *University High School, The University of Chicago.*
ADDRESS OF WELCOME—DR. ROBERT M. HUTCHINS, *President of the University of Chicago.*
RESPONSE FOR THE ASSOCIATION—WALTER G. GINGERY, *George Washington High School, Indianapolis, Ind.*
ADDRESS—PROF. ARTHUR H. COMPTON, *The University of Chicago.* Subject: What Things Are Made of.
ADDRESS—PROF. M. F. GUYER, *The University of Wisconsin.* Subject: Democracy, A Biological Problem.

Noon

Luncheon—12:15 P. M. Hutchinson Commons.
Exhibits are in Mandel Hall Corridor and Reynold's Club.

Afternoon

Sectional Meetings—1:30. See Section Programs.
Social Hour—4:00. Reading Room, Reynold's Club.
Journal Meeting—4:30-5:30. Third floor, Reynold's Club. Journal Committee, Departmental Editors, Editor and Business Manager of SCHOOL SCIENCE AND MATHEMATICS requested to be present.
Meeting of Nominating Committee—4:45. Little Theater, Third Floor, Reynold's Club.
Inspection of Exhibits—4:00-6:00. Your problem of what to buy and where to buy it, may be solved by inspection of the exhibits.
Annual Reception—6:00-7:00. Parlors of Ida Noyes Hall. Reception Committee in charge.

Evening

Annual Dinner—7:00. Ida Noyes Hall. Tickets, $1.00. Make reservations early.
ADDRESS—8:15. Theater, Ida Noyes Hall. DR. WM. M. MCGOVERN, *Field Museum and Northwestern University.* Subject: Asia in World History.

Saturday, November 30, 1929

Reynold's Club and Mandel Hall,
The University of Chicago

Morning

Annual Business Meeting—8:30-9:30. Little Theater, Third Floor, Reynold's Club.

Members of the Association are urged to attend the business meeting. It will begin promptly at the time designated. Chairmen of committees are requested to have reports written.

General Session, Mandel Hall

ORGAN RECITAL—9:30-9:45. JAMES W. HOGE, *University High School, Chicago, Ill.*

ADDRESS—PROF. DUNHAM JACKSON, *University of Minnesota, Minneapolis, Minn.* Subject: Statistical Applications of Elementary Mathematics.

ADDRESS—PROF. N. HENRY BLACK, *Harvard University.* Subject: Training of Science Teachers Here and Abroad.

ADDRESS—DR. FRANK T. GUCKER JR., *Northwestern University, Evanston, Illinois.* Subject: Measuring the Millionth of a Centigrade Degree to Test Modern Scientific Theories.

Luncheon—12:30. Hutchinson Hall. Newly elected officers, Board of Directors, Editor and Business Manager of Journal are to be present at this luncheon following which there will be a short business meeting.

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SECTIONAL MEETINGS

Friday, November 29, 1:30 P. M.

Admission by card. Be on time

BIOLOGY

Botany Building—Room 13

Appointment of Nominating Committee.
The Problem of World Population.
Professor M. F. Guyer, Chairman Department of Zoology, The University of Wisconsin.
The Story of Illinois' Pre-History.
Professor W. M. Krogman, Deparmtent of Anthropology, The University of Chicago.
Developing Skill in Scientific Thinking.
Rudolph Bretz and Hilmer Luckhardt, High School students.
What Do You Want in the "Journal"?
Discussion led by Jerome Isenbarger, Crane Junior College, Chicago; J. W. Hadley, Shortridge High School, Indianapolis, Ind. Dep. Editors.
General Discussion.
Election of Officers.
A trip will be conducted to the University Chapel Tower on Saturday afternoon.

CHEMISTRY

Kent Chemical Laboratory—Room 20

Appointment of Nominating Committee.
Liquid Ammonia as a Solvent.
Dr. Warren C. Johnson, Assistant Professor of Chemsitry, University of Chicago.
Some Devices for Teaching High School Chemistry.
Russell S. Howard, Lyons Township High School, LaGrange, Ill.
The Genesis of an Industry.
William Hoskins, Mariner and Hoskins, Chicago, Ill.
What Do You Want in the "Journal"?
Discussion.
General Discussion.
Election of Officers.
Inspection of the new John Howard Jones Chemistry Building.
Leader, Dr. H. I. Schlesinger, Professor of Chemistry, University of Chicago.

GENERAL SCIENCE

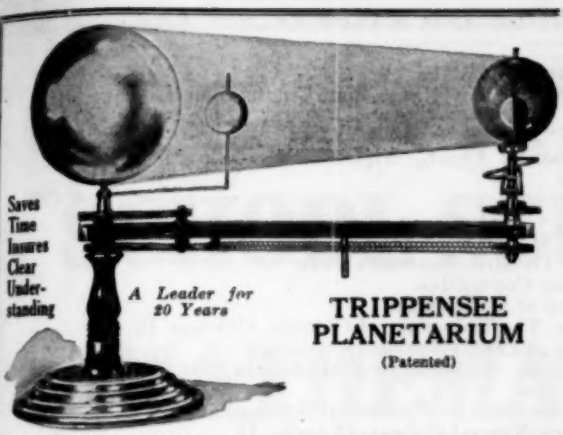
Mandel Hall

Appointment of Nominating Committee.
Let's Get Together.
Howard C. Kelly, in charge of Science, Springfield, Mass.
The Next Step in the Making of a General Science Curricula.
Professor C. B. Yager, State University of Iowa.
The Relative Teaching Values of Certain Common Practices with Examination Papers.
Frances D. Curtis, Associate Professor of the Teaching of General and Biological Science, University of Michigan.
What Do You Want in the "Journal"?
Discussion led by Ira C. Davis, University High School, Madison, Wis. General Science Dept. Editor.
General Discussion.
Election of Officers.

GEOGRAPHY

Rosenwald Hall—Room 22

Appointment of Nominating Committee.
Functions of Secondary School Geography.
Dr. Charles C. Colby, Department of Geography, the University of Chicago.
Some Problems in the Use of Contracts in Teaching Geography.
Professor Harry O. Lathrop, State Teachers College, Whiteater, Wis.
General Discussion.



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The Chicago Plan—Geographical Zoning, etc.
Mr. Eugene S. Taylor, Manager, Chicago Plan Commission, Chicago, Ill.
What Do You Want in the "Journal"?
Discussion led by Katherine Ulrich, High School, Oak Park, Ill., Geography Dept. Editor.
Discussion.
Election of Officers.

MATHEMATICS
Little Theatre, Reynold's Club

Appointment of Nominating Committee.
Definition and Classification of Geometries.
Professor Ernest P. Lane, The University of Chicago, Chicago, Ill.
Combined Courses in Plane and Solid Geometry.
Professor Dunham Jackson, University of Minnesota, Minneapolis, Minn.
Method of Handling the Unit Plan of Teaching in Mathematics.
Mr. O. M. Miller, Chicago Normal College, Chicago, Ill.
What Do You Want in the "Journal"?
Discussion led by C. N. Mills, Ill. State Normal University, and J. M. Kinney, Crane Junior College, Chicago. Mathematics Dept. Editors.
General Discussion.
Election of Officers.

PHYSICS
Ryerson Physics Laboratory, Room 32

Appointment of Nominating Committee.
The Paradox of Light.
Dr. Arthur Compton, The University of Chicago.
The Teaching of Radio in High School Physics.
Mr. Charles Webb, Soldan High School, St. Louis, Mo.
Some New Experiments in Physics.
Mr. H. Clyde Krenerick, North Division High School, Milwaukee, Wis.
A Study of the Physics Involved in a Selected Group of Occupations
Mr. William A. Richards, Morton Junior College, Cicero, Ill.
What Do You Want in the "Journal"?
Discussion led by Dr. Duane Roller, The State University of Oklahoma, Norman, Okla., Physics Dept. Editor.
General Discussion.
Election of Officers.

TO HELP SCIENTISTS.

Sigma XI, the society for the promotion of research, is now on its annual hunt for scientists who need financial help in their studies. Grants ranging from $100 to $1000 are available without restriction as to where the work is done.—*Science News-Letter.*

NO PAIN SENSATION.

When you cut your finger, you may be under the impression that you are experiencing a sensation of pain. But this is not the case, according to a French psychologist who specializes in the study of the human sensations.

There is no pain sensation, this professor, H. Pieron, of the College of France, told the International Congress of Psychology in New Haven. Pain is really an emotional level which may be reached when certain specific sense organs are stimulated, he explained.—*Science News-Letter.*

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